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ABSTRACT

Eight papers present information about children's motor development and its application for program design. Jerry R. Thomas, Kathi T. Thomas, and Jere D. Gallagher discuss "Children's Processing of Information in Physical Activity and Sport." In "Toward Inclusion," G. S. Don Morris considers characteristics of children and of motor tasks with regard to program development and evaluation. Vern Seefeldt discusses "Equating Children for Sports Competition: Some Common Problems and Suggested Solutions." "How do Children Perceive the Sport Experience?" is the subject of a paper by Jerry R. Thomas and Jere D. Gallagher. Harriet G. Williams' paper describes "Neurophysiological Correlates of Motor Development: A Review for Practitioners." Jacqueline Herkowitz writes about "Developmentally Engineered Equipment and Playspaces for Motor Development and Learning." "Motor Performance and Anthropometric Screening: Measurements for Preschool Age Children," the seventh paper, is written by Arlene M. Morris, Anne E. Atwater, Jean M. Williams, and Jack H. Wilmore. In "From Theory to Practice: A Summary," Bob Pangrazi, Nonda Chomokos, and Debbie Massoney focus on key points of the papers and on their application to teaching. (CJ)

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MOTOR DEVELOPMENT:

THEORY INTO PRACTICE

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MOTOR DEVELOPMENT: THEORY INTO PRACTICE

MONOGRAPH 3 1981

Table of Contents

Children's Processing of Information in Physical Activity and Sport.....1
Jerry R. Thomas
Kathi T. Thomas
Jere D. Gallagher

Toward Inclusion.....7
G. S. Don Morris

Equating Children for Sports Competition: Some Common Problems and Suggested Solutions.....11
Vern Seefeldt

How do Children Perceive the Sport Experience?.....21
Jerry R. Thomas
Jere D. Gallagher

Neurophysiological Correlates of Motor Development: A Review for Practitioners.....29
Harriet G. Williams

Developmentally Engineered Equipment and Playspaces for Motor Development and Learning.....39
Jacqueline Berkowitz

Motor Performance and Anthropometric Screening: Measurements for Preschool Age Children.....47
Arlene M. Morris
Anne E. Atwater
Jean M. Williams
Jack H. Wilmore

From Theory to Practice: A Summary.....65
Bob Pangrazi
Nonda Chomokos
Debbie Massoney

References.....73

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CHILDREN'S PROCESSING OF INFORMATION IN PHYSICAL ACTIVITY AND SPORT

Jerry R. Thomas
Kathi T. Thomas
Jere D. Gallagher

The purpose of this monograph is to present information about motor development in a manner intended to enhance its usefulness for program design. It is a challenge to attempt to unify the apparently disparate aspects considered in this monograph and one that is not easily met. The unifying concept that appears most promising is also the one most recently applied to this age level: information processing, with particular focus on the role of memory processes. The central thesis to be considered is that the processes in the memory system are not used, or are used to a lesser extent, in younger children. This results in slower and less effective processing which is reflected in poor motor performance and learning. The elements or strategies to be considered are: processing time, processing speed, rehearsal, labeling, memory organization, size of the data-base, and quality, intesity, and span of attention. While the processing model proposed is not unique, its observations/ideas accord well with those concerning cause and effect relationships between developmental changes in memory and age-related changes in motor performance and learning which are the topics of succeeding papers in this monograph.

Relationship to Other Papers

In the Morris paper, TOWARD INCLUSION, characteristics of the child and the task are considered with regard to program development and evaluation. Application of his suggestions for practice can only be enhanced by an understanding of the developmental nature of children's information processing.

The Seefeldt paper, EQUATING CHILDREN FOR SPORTS COMPETITION, focuses on physical and physiological maturation. Consideration of these aspects of development is crucial if we are to understand that the child is an holistic unit and that all aspects of maturation interrelate. In addition, several of his suggestions for restructuring sports competition can also be understood from the viewpoint of developmental processing. Seefeldt makes another important point, true of processing also, that chronological age is not the best indicator of physiological readiness.

In our own paper, HOW DO CHILDREN PERCEIVE THE SPORT EXPERIENCE?, we suggest that in sports, almost every consideration (of mobility, function, environment) involves cognitive processing of information. The literature suggests that age differences effect winning or losing and rewards, thus we suggest that decisions about these concerns should be related to the development of the memory system.

It is particularly interesting to note how closely the age-related neurophysiological changes reported by Williams in NEUROPHYSIOLOGICAL CORRELATES OF MOTOR DEVELOPMENT IN YOUNG CHILDREN correspond to the ages that appear important in memory development. For example, the more general nature of motor neuron firings seen when younger children attempt a new task may be associated with their inability to recode independent units of information from long term storage and develop a specific plan for movement.

The design and development of equipment and play space considered by Herkowitz is clearly based on information about how children learn at various ages. The developmental model we propose complements her suggestions for promoting skill acquisition.

Morris, Atwater, Williams, and Wilmore offer an assessment procedure for evaluating children's motor performance. Since these tests are for children from 3-6 years, the results should be related to the child's information processing capabilities at that age. Practitioners should remember, for instance, that children of this age are unlikely to rehearse or organize material in memory. Also, attentional development will be at a low level. These factors must be considered when tests are constructed and when the data are interpreted, or the results will not be meaningful.

Thus we see that the papers in the monograph, while not planned with reference to a processing model, do, in fact, relate to it. In most cases the suggestions made in the papers are reflective of the processing model and the elements and strategies considered. In other cases, information which further supports the processing model is presented. Finally, as in the Seefeldt paper, the aspect considered complements rather than reflects the processing model through consideration of another aspect of growth and development.

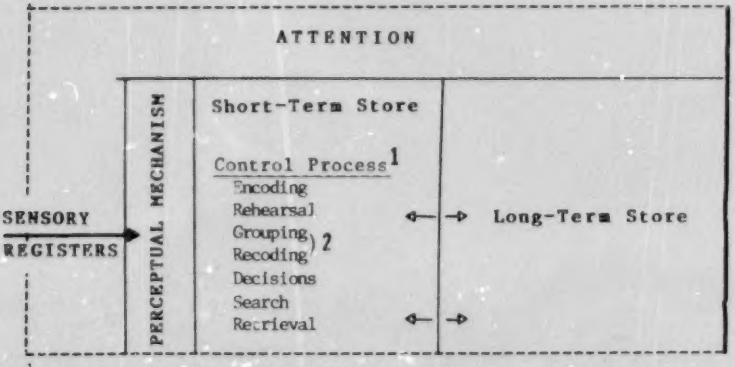
Memory Processing Model

Reinforcement of, or change in, motor behavior can be attributed to three sources: external information, i.e., situational demands and feedback from the performance environment; internal feedback, proprioceptive information resulting from movement; and internal information, memory of previous performances or similar situations. Cognitive, or information processing, ability refers to the capacity of an individual's memory system to use all of the sources of information to reinforce and/or change perceptions, decisions, and behavior. The use of the memory system affects our own perception and performance in sport and physical activity and also affects the way we perceive others behaving and what we perceive as causes of this behavior.

The statement "children are not miniature adults but are in the process of developing" generally refers to physical

growth. We sometimes forget that the statement also applies to emotional and mental development. The fact that adults process verbal and motor information more efficiently than children has been supported by numerous studies (Chi, 1976; Drucker & Hagen, 1969; Eimas, 1969; Farnham-Diggory, 1972; Gallagher, 1980; Gallagher & Thomas, 1980; Hagen, 1972; Thomas, Mitchell & Solmon, 1979; Winther & Thomas, 1981). According to Chi (1976) as children grow older, they become able to process more cognitive information within a given time or can shorten the time needed to process a given piece of information. Clearly, shortening or lengthening the processing time will affect motor performance, particularly that of younger children (Gallagher & Thomas, 1980). Why are the memory processes of children less efficient, and why do they respond more slowly to demands?

We propose that several processes used in the memory system are much less efficient in younger children. Figure 1 presents a model of memory designed to illustrate the developmental nature of learning and performance. Several characteristics of the model are related to memory development. We see that information is fed into this system from the various sensory registers (vision, audition, kinesthesis, etc.). The three aspects of the model most related to development are short-term store (STS), long-term store (LTS), and attention. All of the action is in STS. It is used to evaluate incoming information from the sensory registers, to search LTS for data on related past experiences, to rehearse relevant information, make decisions, initiate actions, and to monitor these actions as they are performed. The ability to use these many processes (encoding, rehearsal, grouping, recoding, decision-making, search and retrieval) in STS develops during childhood and into adolescence. Younger children do not use some of these processes and they use others



[1]Control processes develop with aging
[2]Grouping and recoding combined is organization

Figure 1. Information processing model with developmental implications

inefficiently, so that the entire processing function is slower and less effective than in adults. The result is poorer motor performance and learning.

Rehearsal and Labeling

Two studies (Gallagher & Thomas, 1980b; Winther & Thomas, 1981) demonstrate that by manipulating either rehearsal strategies or labels (one form of encoding) for movement positions, younger children's motor performance can be improved and that of older children and adults can be depressed. These two studies support Flavell's hypothesis of production-mediation deficiency (1971) which indicated that children may or may not be capable of producing the desired cognitive strategy at a given age. Producing the strategy, however, does not mean they will necessarily employ this strategy (mediation deficiency). For example, a 5-year-old child can rehearse (does not have a production deficiency) when cued to do so; but the child will not spontaneously produce a rehearsal strategy (does have a mediation deficiency). Generally, spontaneous rehearsal does not begin until about 7 years of age. Between 7 and 11 years a considerable increase in the use (and quality) of rehearsal strategies occurs. The child of 11 or 12 uses a strategy similar to that of an adult.

The young child typically rehearses the same item over and over, e.g., hop-hop-hop, skip-skip-skip, jump-jump-jump, whereas an adult will rehearse several times in combination, e.g., hop-skip-jump, hop-skip-jump. Since the adult strategy improves performance, teaching this strategy to children should enhance skill acquisition.

Labeling is viewed as "rehearsal" for children under 5 years of age. With these children, and to some extent with adults, relevant labels enhance memory for an item and recall is greater than when either no label or an irrelevant label is used. A labeling strategy could be applied to leaping, for instance, by naming the leading and trailing foot positions at the apex of the leap 4 and 8 o'clock respectively.

Memory Organization

Grouping. Another important process which develops is organization of memory by a combination of grouping and recoding. "Grouping" is the process of placing independent units of incoming information together. Adults, for instance, typically group a series of random numbers into sets of three for rehearsal and possibly storage in LTS. A young child will rehearse and store each number independently. This again results in poorer performance on the part of the child. Evidence indicates that remembering a series of movements is affected in the same way (Gallagher & Thomas, 1980a). It is possible to facilitate learning in young children by manipulating the incoming stimuli. Movement sequences can be broken into logical units to be rehearsed together. In folk

dance, a natural grouping might be step-step-step-hop, step-step-step-hop.

Recoding. The second process in organization of memory, recoding, involves searching LTS for two or more items of stored information which could logically be put together. The two pieces of information are combined (recoded) in STS and re-entered in LTS. When needed they will require less space in STS. Recoding might involve taking two well-learned movements, such as the step and the hop, and combining them to create a new movement, the skip. Grouping and recoding are two ways to reduce the demand for working space in STS. It is important that demand be reduced since the working space in STS is limited. The LTS is believed to be unlimited. As movements become well-learned they are increasingly automated, and less working space in STS is required, freeing working space for other cognitive aspects of skilled performance. Thus, when the skip, a recoded step-hop, becomes automatic, it can be combined with other locomotor patterns to comprise more interesting, difficult and well-rehearsed sequences.

A series of studies by Gallagher (1980) provides information regarding the development of rehearsal and organization in STS and its relation to motor performance. Rehearsal strategies begin to be used in a spontaneous way at about 7 years, with a rapid increase in both frequency and quality of rehearsal between 7 and 11 years. Organization in memory, however, lags considerably behind rehearsal in its use. In teaching children, we should remember this important information about strategy development. We need to cue younger children (4-6 years) to rehearse, but beginning at age 7 and continuing to age 11 they will begin to use a rehearsal strategy spontaneously with increasing sophistication. Organization of memory (to reduce STS demands) begins to occur at about age 7, but the child frequently needs to be cued. At approximately 10 or 11 years, there is a considerable increase in the use of this strategy. The developmental literature also supports the notion that other memory processes (speed of encoding, decision-making, and search and retrieval) increase across the childhood years. However, specific developmental patterns in relation to motor performance and learning have not yet been identified.

Data-base

The second aspect of this developmental model is the data-base in LTS (Chi, 1976; Thomas, 1980). While LTS is viewed as unlimited in capacity, the data-base of young children is not nearly as extensive or well-developed as it is in adults. This means less information with which to compare incoming stimuli, as well as fewer units to recode. In fact, one might hypothesize that recoding as a process develops later because there is a limited data-base in LTS from which to recode. This may be partially responsible for the poorer motor performance and learning of younger children. This should be

kept in mind when skill acquisition demands recoding. Teachers need to be aware of the typical content of LTS and systematically attempt to expand and utilize LTS.

Attention

Attention is particularly interesting as a memory process. Sometimes, attention is used in a very specific way to refer to the ability to select pertinent aspects from the sensory register (Hoving, Spence, Robb, & Schulte, 1978). At other times, attention has assumed a more pervasive part in memory function and might be classified as similar to a control process (Hagen & Stanovich, 1977). The model presented here supports this latter, more general, view of attention. Its placement suggests two things: first, attention can be directed to any aspect of memory, from selecting important features of a sensory display to rehearsal in STS, to search and retrieval in LTS; and second, the amount of attention is limited. If simultaneous demands within, or between, components of memory exceed the available attention, performance will deteriorate. Of course, this view is not original with us (e.g. see Kahneman, 1973).

Attention is also developmental, i.e., children learn to control it more effectively with age (for theoretical explanation see Ross, 1976; for applied explanation see Stratton, 1978). This circumstance, in combination with recoding of movement information, reduces attentional demands of STS with increased age. Thus increased amounts of attention can be directed to different needs in the memory system. For instance, we see attention directed first toward the locomotor patterns, then toward the music, when a performer is learning or creating a dance.

Although the processing model we propose is not unique, it does combine usefully with what we know of developmental changes in memory and their effects upon age-related changes in motor performance and learning.

Summary

We have presented a developmental model of information processing as an overall framework into which the various aspects of motor development considered in this monograph would fit. The intent was to help the reader understand how children learn and so presumably to apply the information in this monograph to the real functions of children's processing of information as they perform in physical activities and sports.

TOWARD INCLUSION

G. S. Don Morris

Physical activity can and should benefit every human being. The literature abounds with information demonstrating the positive aspects of physical activity for children and adults. Unfortunately, many of our movement and sports programs exclude participants rather than include them in a manner that could enhance their skill development and improve their movement confidence. Exclusion occurs because our programs are not structured for inclusion. Several program and movement task components that can be controlled by the teacher and coach significantly affect this exclusion/inclusion problem. If these components are properly managed, the potential for including every performer exists. These components may be grouped into four categories related to: the child, the movement, the task and the method. These categories and the components that fall into them are presented in Table 1.

Inclusion Skills

In order to insure that all children are included in sport activities and have equal opportunity to experience success, sport or activity leaders must have the knowledges, skills, and strategies reflected in Table 1. These include: knowledge of the child-centered characteristics that affect motor performance (growth/maturation, information processing, emotional/social); the ability to describe, analyze and assess the movement as it should be done and as the child executes it; the capacity to design movement tasks to match the developmental status of the child; and a repertoire of presentation and organizational strategies.

Table 1. Inclusion Components

CHILD	MOVEMENT
Growth/Maturation	Description
Information Processing	Analysis
Emotional/Social	Assessment

METHOD	TASK
Types of Methods	Design/Task Complexity
Management Strategy	Package/Games Analysis

Although all four of these areas are important, only two of them, the child and the task, will be considered in detail here. Further information on movement description and analysis and on presentation and organizational strategies may be found in Morris (1980a).

The Child

The aspects of child development that will be considered are physical maturation, cognitive (information processing) maturation, and emotional and social maturation. Consideration of these aspects will enable the leader to assess what each child can do. This is crucial in planning experiences for each child and in accurately evaluating each child's progress. Some of these aspects will be applied when manipulation of task complexity is discussed in the next section.

Growth/Maturation Status. Between the ages of three and twelve significant physical growth and development changes occur, for example, in the skeletal and muscular systems, in the nervous system, and in the cardiovascular system. These changes affect a youngster's motor performance. Children in the early stages of growth and development (maturationally, not necessarily chronologically), cannot run as fast or jump as high as children at later stages. Flexibility may decrease as development proceeds with the result that younger children may execute skills in a manner that the older, less flexible child cannot. Similarly, changes which occur with maturation of the nervous system and the cardiovascular system can affect the child's capabilities and performance.

Cognitive (Information Processing) Status. As the child matures information processing capabilities develop and improve. Information processing encompasses the ability to receive, decode, integrate, analyze, and organize information. Perhaps the most important information the child must process arrives through the visual system. As the child's cognitive status changes, visual information is processed more rapidly and more accurately, leading to improved motor performance. In addition, it is important to note that the child progresses from processing information from one source only to integrating information from several sources.

Emotional/Social Status. As the child matures, emotional and social factors affect movement performance. Recent evidence by Keogh and Griffin (1981), for example, suggests that a child's self-concept or confidence in attempting new movement tasks affects performance outcome. It is possible to assist the development of movement confidence by carefully planning the nature and composition of movement tasks presented to the child.

In planning for goals it is important to consider the social maturation of the child. In light of evidence (Kohlberg, 1963; Martens, 1975; Orlick, 1978) regarding the socialization process, for example, it is unrealistic for a coach to expect an egocentric 6-year-old child to be concerned with the outcome performance of the team. Usually by age 9 to 11 most children begin to express concern for team goal attainment. Sport leaders need to consider seriously the developmental level of the team members when deciding what degree of importance will be placed on team standings or team play.

The Task

While the teacher/coach cannot manipulate the

developmental level of the child, it is possible and necessary to manipulate the task through design and packaging strategies and so match the task complexity to the developmental level of the child. In addition, special attention must be given to the sequence of tasks presented to the children.

Design/Task Complexity. The level of difficulty of a task or a series of tasks can be manipulated by employing Morris' Task Complexity Procedure (Morris, 1980a). The procedure involves manipulation of environmental factors, physical and/or biomechanical factors, and movement factors. By varying these factors from least to most difficult, a task complexity spectrum can be established. A task complexity spectrum for the environmental factors of ball and background color as they affect a child's catching ability is presented in Table 2.

Table 2: Task Complexity for Catching (environmental factors)

Complexity	Ball Color	Background Color
Least difficult	Blue	Light
	Yellow	Dark
	Red	Multi-colored
Most difficult	White	

Using the information in Table 2, the teacher can quickly determine that it is easiest to catch a blue ball against a light background and most difficult to catch a white ball against a multi-colored background with the other combinations falling between these two extremes (Cockerill & MacGillivary, 1981; Morris, 1976). Another example, in which the interaction between task complexity factors is more apparent, is presented in Table 3. As a series of balance tasks is developed, using

TABLE 3. Task Complexity Scheme for Balance

TASK COMPLEXITY	SIZE OF SUPPORT BASE	LOCATION OF CENTER OF GRAVITY	HEIGHT OF CENTER OF GRAVITY	SPEED
Simple	8 body parts serving as base of support	C of G directly over base	C of G close to base	Slow
	4 body parts	C of G slightly	C of G higher	Medium
	1 body part	C of G moderately	C of G still higher	Fast
Complex				

information in Table 3, the factors may be varied one, two or more at a time. The more the Task Complexity Procedure is used the more readily its subtle interaction effects are understood. Ideally, information about motor development can suggest ways of manipulating tasks so that they can be matched to each

child's developmental status.

Packaging/Games Analysis. Manipulating task complexity is to a single task as games analysis is to a total game. Just as the notion of task complexity requires analysis of the task, so games analysis requires careful assessment of the game so that each game may be designed to include children of all skill levels. Assume that in a class of 39 children the following range of skill exists:

some children can hit a regulation softball with a regulation bat
some children can hit a larger ball thrown underhand
some children can hit a stationary ball with an oversize bat
some children can hit a large ball on the ground with a large bat

Each child can have the opportunity to experience success in the game if it is structured so that each batter is allowed to make the following decisions:

how the ball will be delivered
the size and color of the ball
the type of striking implement to be used

The elements that might be manipulated are: number of players, type of movement, organizational pattern, type of equipment, limits, and scoring. (Morris, 1980a). By allowing for diversity in elements and by enabling children to participate in decision-making, all children can be included in each game.

Summary

Although the model presented encompasses the child, the movement, the task, and the method, only two of the components, the child and the task were discussed. The interaction between and among components as well as between and among the elements within the components must be stressed. The manipulation of the task depends upon the developmental level of the child and the developmental level of the child is an interaction of physical, cognitive and emotional/social elements. The task or game complexity is based upon the interaction of the particular elements used in the task or games analysis.

The necessity for considering the interaction among the various components and elements of the model can be provided by a baseball example. The equipment must be matched to the child's physical characteristics, the speed and trajectory of the pitched ball must be matched to the child's cognitive capabilities, the structure of the team must take into account the child's emotional/social development, the particular movement elements and mechanics must be appropriate for the child's motor development level, and the method and organizational pattern used must be suitable for the child's capabilities. The use of the components to structure movement environments will help to realize the goal of INCLUSION in movement experiences for all children.

EQUATING CHILDREN FOR SPORTS COMPETITION: SOME COMMON PROBLEMS AND SUGGESTED SOLUTIONS

Vern Seefeldt

Athletic competition during the childhood years has become so popular that it is considered an American institution by many adults. Children are often enrolled in some competitive programs even prior to attaining elementary school age, based on the assumption that the experience would have a positive effect on their physical, social and emotional development. However, the notion that sports competition is inherently good for children has been challenged frequently by physicians, educators and parents in the past two decades. Implications are that the initial goals which stressed skill learning, co-operation and self-discipline, are often eroded or overridden by an emphasis on winning the contest. Often the right of children to learn motor skills in a supportive environment has been superseded by an atmosphere of intolerance and rejection. Sports competition for children has now become a controversial issue, instead of enjoying the universal acceptance that accompanied its early history.

Much of the controversy that surrounds athletic competition for children is related to the incongruence between the expectations of children who participate in the programs and the demands of adults who control the competition. Variations in body size and maturation among children of shared chronological age are obvious, but often ignored, factors related to motor proficiency. An understanding of the interrelationships between physical size, biological maturity and motor prowess is essential if the adults who supervise children's programs are to provide experiences that focus on individual development of the child rather than on the common practice of excluding from competition those children who are not held to be at a competitive level of proficiency.

Equality is a concept that is very important to children. They will suspend their play frequently to argue about the rules that apply to individuals and situations in the interest of "what's fair." However, in organized sports the conditions and rules are imposed by adults, frequently with little or no modification from the games designed for adults that served as their model. Equality in competition implies that all competitors will have an opportunity to strive for victory. Implicit in this definition is the assumption that each competitor also has a chance for victory or success in the

contest. Victory, in this context, is not restricted to the final score, but includes the broader concepts of improvement over a previous performance, success in a skill that previously was unattainable, and contributing to the success of a teammate. Defining winning or victory in this way ensures that its effects will be experienced by a greater number of competitors.

Dilemma: Providing Equality of Competition in Children's Sports

The essence of sports for children is a non-threatening environment in which they can learn fundamental motor skills at a rate that is based upon their individual abilities. Yet the manner in which youth sports are conducted is frequently in direct contradiction to sound education practices as viewed by a majority of parents, coaches and physicians. How has the present structure of athletics for children and youth evolved, and why are some of the undesirable practices so difficult to change? The answers to these questions are directly related to long standing traditions in sports-related programs.

Equality in children's sports is difficult to achieve because of the many components that affect it. Variables such as the quality of coaching, motivation, skill level of the opposition, and previous experience are all important considerations in a formula that is designed to provide for equality of competition. However, only the individual variations of body size and maturation will be discussed in this chapter.

A primary criterion for qualification in children's sports programs is chronological age. In many athletic events it is the sole means of "equating" children for competition. Yet anyone who has observed children as they learn motor skills is aware that vast differences exist between them within one chronological year. This problem is compounded when the age of qualification spans two or more years, as is the case in the nationally affiliated programs such as football, baseball, soccer, and ice hockey. The reason for a reliance upon chronological age as a basis for grouping children lies in its ease of administration. By comparison, any other criteria require more time and effort in their assessment and implementation. Furthermore, the inclusion of other variables in the classification formula does not always guarantee equality of opportunity to the participants.

The second pervasive problem in children's sports is the adherence of coaches to a "professional model," by which exclusion and elimination of participants is a part of the process involved in the selection of competitors. Instead of creating an environment in which all children can learn skills, each child at his or her own rate, many sports programs are conducted to further enhance the skills of those who are

already quite proficient, while the poorly skilled are excluded or ignored. These procedures contribute to the dissatisfaction that children have with age-group athletics and lead to such a high attrition rate that by age 14 many potentially fine athletes no longer try out for the reduced number of opportunities that are available in the world of children's sport (Orlick, T. & Botterill, C., 1975; Michigan Youth Sports Study, 1976).

Growth and Maturational Changes that Influence Performance

It is common knowledge that as children grow older they also grow in their ability to perform more complex tasks. In growing children, measures of strength, power, endurance, and accuracy are directly related to increases in age and body size (Jones, 1949; Clarke, et. al., 1961; Parizkova, 1968). However, body size and biological age (an assessment of the individual's rate of progress toward maturity) are often ignored in favor of chronological age when children are classified or placed into groups for competitive purposes.

The distinction between chronological and "maturational" or "biological" age was recognized long before athletic competition for children reached its popularity in the United States. Crampton, in 1908, pointed to the advantages of grouping children for educational purposes on the basis of "physiological age." Concurrently, Rotch (1908) wrote:

> When, however, the question of age is brought to bear on our school systems, whether in classifying and grading children as to their studies, or in pitting them against each other in athletic sports, it becomes a very serious question as to whether chronological age is a wise decision during the formative period of early life. (p.1197)

Krogman (1972) compared chronological and biological age to a foot race in which all of the contestants begin at the same time, but each crosses the finish line according to his or her own ability.

Because of the positive correlation between body size and motor prowess at the extreme ends of the growth continuum, the variability of certain parameters within a chronological age group is of considerable interest. Data taken from growth charts prepared by Meredith and Spurgeon (1975) illustrate this point. For example, the standing height of normal boys at 14 chronological years, ranges from 54 inches for the shortest to 74 inches for the tallest. In weight, the lightest boys weighed only 70 pounds, while the heaviest boys within the normal range were 184 pounds. For girls 12, 13, and 14, a similar variation was noted. At each age the difference between the shortest and the tallest girls was 14.5 inches. In weight, the greatest difference came at age 15, with the

lightest girls weighing 65 pounds, and the heaviest weighing 184 pounds.

The variation in biological age for a specific chronological age within a sex is astounding as are the differences for height and weight. Skeletal ages for girls at 12 chronological years ranged from 119 months for late maturers to 180 months for early maturers (Gruelich & Pyle, 1959). Similarly, the skeletal ages for boys at 14 chronological years ranged from 138 months for late maturers to 202 months for early maturers. At 14 years of chronological age, the difference in skeletal age between the earliest maturing girls (208 months) and latest maturing boys (138 months) was 70 months. These examples illustrate that a specific chronological age is likely to encompass individuals whose size and biological maturity are similar to the averages of children who are two and three years younger or older than the average for their chronological age. When this situation is compounded by including children over a four year age span in one competitive group, as is the case with some nationally controlled sports programs, the differences in biological maturity within the group could encompass ten years.

The close association between skeletal age, height, weight, and motor development indicates that the most mature children within an age group have an advantage in sports competition. Although the selection process for team membership is not well documented, several reports confirm that maturational age is of considerable importance for success in certain age-group sports situations. Krogman (1959) noted that of the 55 boys who participated in the 1955 Little League World Series, 71% had skeletal ages greater than their chronological ages and 25 boys had skeletal ages that exceeded their chronological age by more than one year. Krogman suggested that the baseball players in his sample were successful because they were "more mature, biologically more stable, and structurally and functionally more advanced." Previously, Hale (1956) reported that 45.5% of the boys who participated in the 1955 Little League World Series were post-pubescent in terms of secondary sex characteristics. Most of the important offensive and defensive positions (clean-up hitter, pitcher, first base, and left field) were filled by post-pubescent boys.

The influence of size and advanced maturity on motor performance does not appear to be limited to skills involved in baseball. Rochelle, et al. (1961) noted that 71% of the boys who comprised their sample of junior high school tackle football players had skeletal ages in advance of their chronological ages. Similarly, Cumming and co-workers (1972) found that boys and girls at a summer camp for track and field athletes were advanced in skeletal age. Of greater interest, however, is that skeletal age was a better predictor of success in most events than height, weight, and chronological age, alone or in combination with one or more of the other variables. In this situation, advanced biological maturity,

although highly correlated with height and weight, accounted for a significant part of the variance that was unexplained when maturity was excluded from the equation.

The relative importance of skeletal age as a classifying criterion in the presence of height and weight, as reported by Cumming, is not consistent with the data reported by Rarick and Oyster (1964) who found that when height and weight preceded skeletal age in the step-wise regression equation, skeletal age added little to the prediction of motor performance in boys 8 and 9 years of age. Findings similar to those of Rarick and Oyster occurred when Motor Performance Study data from 9 to 12 year old boys were analyzed for relationships between motor skills, physical size, and skeletal age (Howell, 1979). These studies suggest that the effect of biological age on specific sport skills may be cumulative, with its greatest impact coming during the circumpuberal period when the greatest variation exists among athletes of the same chronological age.

Special Conditions and Stressful Play

Although the beneficial effects of activity are an important concern to parents, educators, and the medical profession, it is the potential detrimental influences of sports on growth and development of children that has generated the greatest interest and controversy. Rarick (1973) has categorized these hazards into three concerns: 1) the physical demands and psychological stresses of highly competitive athletics may be great enough to affect growth and development adversely; 2) repeated stress resulting from particular movements peculiar to a sport may in some instances be sufficiently great to induce trauma to a body part, thus impairing its normal growth; and 3) a blow or forceful impact may be sufficiently great to be fatal or to do permanent damage to a growing structure. Although the information concerning the effects of sports programs on these three categories of hazards is incomplete, the growing body of evidence does provide a basis for making prudent judgements concerning the intensity of training regimens in which children are involved.

The reduction or cessation of growth in young athletes as a result of training is of major concern. Our own data (Seefeldt, et.al., 1979) and those of McCammon (1970) on the longitudinal growth of healthy boys within the age range of 13 to 17 years indicate that the annual mean height gain is 7.0 centimeters. This figure is not a true representation of actual growth, however, since a study of individual patterns indicate that annual increments of 10.0 to 12.0 centimeters are not uncommon during the year of peak growth.

Several studies suggest that vigorous training programs may impede growth in children. Rowe (1933) and Fait (1951) have indicated that six-month programs of interscholastic athletics may have had a curtailing effect on young athletes. Schuck (1962) reported a differential effect on the growth of seventh, eighth, and ninth grade boys as a result of a 12 game

versus a 17 game season. Clarke (1974) reported that no significant changes in mean standing heights of high school wrestlers occurred during the course of the season, while Tipton's (1970) sample of high school wrestlers averaged only 1.5 centimeters gain in standing height over a 6 month period.

When the evidence of temporary cessation or retardation of growth is viewed against the model of catch-up growth proposed by Prader and Tanner (1963), one must question whether any activity that restricts or delays the normal growth of individuals is in their best interest. Prader and Tanner's model suggests that: 1) the human organism is capable of growing much faster than its normal rate in an attempt to recover from an unfavorable conditions; 2) the degree of recovery is dependent on the extent and duration of the deprivation and developmental level of the child; and 3) the full genetic potential of the organism may not be realized because the time that was lost during the deprivation cannot be extended indefinitely.

There is some evidence that training programs can accelerate or modify the growth of the human skeleton. Ekblom (1969) concluded that boys of 11 to 14 years who trained for 32 months had slightly greater increments of growth in height and weight than a randomly selected control group. Parizkova (1968) studied the longitudinal growth patterns in four groups of boys who participated in various levels of physical activity. The 5 year longitudinal study (ages 11 to 15) revealed no significant changes between the groups in height, weight, and biological maturity, but the group that participated in the most strenuous activity program had significantly wider shoulders in relation to hips than did those who were less active. Theoretically, the transverse contractile force of the muscles in the upper extremity caused the shoulders to become wider, while the vertical force of the muscles in the lower extremity acting on the hips resulted in narrower pelvic structures. Adams (1965,1966) reported accelerated growth at both the elbow and shoulder joints of Little League and Pony League baseball pitchers. According to Adams, these changes occurred only in the joints of the throwing arm and were, therefore, attributable to the stresses of throwing a baseball.

In an often quoted study referring to the influence of strenuous physical activity on growth, Astrand and co-workers (1963) reported that a population of champion Swedish girl swimmers were taller than their peer group of girls, but noted that this difference was already present at 7 years of age, prior to the time when most of them were engaged in swimming programs. Astrand's data suggested that the girls may have gravitated to swimming because of some pre-existing characteristics, rather than the commonly drawn implication that the intensity and duration of the training program accelerated their growth in height.

Perhaps the most vulnerable portions of the body to the

stresses of activity are the joints of the elbow, shoulder, knee, and ankle. Numerous medical authorities have suggested that the epiphyses of young athletes are the most susceptible of all tissues to injury, because the ligaments and fibrous capsules that surround the joints are more resistant than the epiphyses to the twisting and shearing forces to which they are subjected (Larson & McMahan, 1966; Sigmond, 1960). The study of Adams (1965) on the elbow and shoulder joints of Little League players supports this contention. Adams noted varying degrees of epiphysitis, osteochondritis, accelerated growth, and separation of the medial epicondules in 76 of the 80 pitchers. Joint damage was present in only 7 of the 47 non-pitchers.

In contrast to the devastating effects of baseball pitching on the elbow and shoulder reported by Adams, Torg (1972) noted that none of the 49 baseball pitchers in his study had abnormalities of the shoulder structure and only 3 had evidence of irregular development of the elbow joint. Torg attributed the difference in incidence of injury between the two reports to the circumstances under which the two groups participated. The former situation was highly competitive and encompassed an extensive playing schedule, while in the latter the emphasis was on participation for purposes of relaxation.

Of equal concern to the acute effects of stressful activity is its potential for both chronic and latent conditions. Although Larson and McMahon (1966) and Sigmond (1960) suggested that bone and joint injuries, if treated promptly, will not have any adverse long-range effects, Lowman (1952) was of the opinion that it is not the detectable injuries such as fractures, dislocations, sprains, strains, and abrasions, but the minute, day-to-day trauma of stressful exercise that results in body misalignment and arthritic conditions that are so prevalent in middle-aged populations.

Common Procedures to be Avoided

The practice of excluding children from team or individual games is likely to have far reaching consequences (Orlick, 1974). Exclusion or elimination from sports often reduces or removes any further opportunities that children may have to practice their skills in their usual setting, while those who are retained as competitors henceforth benefit from systematic, guided practice. Thus, it is likely that the differences between the skilled and unskilled athletes will increase, making it more difficult for those who were excluded to reach the achievement level of their peers in subsequent years. A repetition of these events at an impressionable age may discourage children from making further attempts to become involved in sports programs.

Attempts to identify potential athletes during their childhood with the intent to groom them to "stardom," is also a

dubious practice. Aside from the ethical problems associated with these actions, there is also the likelihood that such ventures will result in a low proportion of successes. The characteristics which determine athletic prowess are numerous, and many of them have an environmental, rather than a genetic, origin. Moreover, the athletic status of individuals is likely to change markedly between childhood and adolescence. Clarke (1968) reported that of the boys who were rated by their coaches as outstanding at some time between 9 and 15 years, only 25% received the same rating at both the elementary and junior high school level. Forty-five percent were rated as outstanding in elementary school but not in junior high school, and 30% were rated as outstanding in junior high school but not in elementary school. It is evident that the extreme conditions of over-emphasis on athletic competition or the deprivation of opportunity to participate in sports could alter the lives of children in these formative years.

Proposal: Restructuring According to Developmental Readiness

Despite the equivocal nature of the evidence pertaining to the influence of sports on children, there is sufficient experiential information to suggest that some constructive changes should be made in the way programs are conducted. Many of the recommendations that follow have been stated by others (Bar-or, 1975; Hurwitz, 1974; Martens, 1978; Rarick, 1973). However, traditions in sport are difficult to change, and perhaps the reiteration of these suggestions will hasten their implementation. The following procedures are designed to circumvent some of the problems that have been identified in the previous sections of this paper.

Team Selection and Classification of Athletes. The criteria for placing children into competitive teams or groups should be expanded to include skill level, previous experience, and biological maturation. Chronological age ranges should never encompass more than two years for athletes who are under 16 years of age. Although it is not generally feasible, various levels of competition should exist within these two-year age spans so that athletes may choose their own level of competition. Governing boards should have the prerogative of moving players to higher or lower levels of competition in situations where athletes dominate games or contests at their present classification level.

When the competitive unit involves a team, its members should be placed into groups on the basis of an evaluation system that is designed to equate the units within the league. Teams should be assigned en masse to coaches, in lieu of "player auctions," lotteries, and the purchasing or recruiting of athletes.

Readiness for Competition. The desire of adults to

organize competitive situations for children often exceeds the desires or capabilities of the children to engage in these activities. For example, how many children at age 8 can throw a baseball within the strike zone when pitching from 45 feet?; throw from home plate to second base in an attempt to erase a stealing runner?; catch a fly ball that has been hit to center field?; throw a runner out at first base from the third base position?; or strike a pitched ball that has been thrown with a horizontal trajectory?

The primary objective of sports programs for children should be to teach them the fundamental motor skills in a socially constructive environment. Yet many sports are conducted by using the professional model as its prototype, with only minor concessions to modifications in rules, field or floor dimensions, and strategies. What is needed is an age-by-age analysis of the contestant's motor and cognitive capabilities, with commensurate adjustments in the conditions under which contests are carried out. In this arrangement, pre-entry competencies would be identified and children would be neither permitted nor compelled to compete until the prerequisite skills and knowledges had been attained. The stipulation of prerequisite standards of attainment of skills and knowledges by competitive level would emphasize skill development at the younger ages. The identification of competencies and required levels of proficiency, by sport for each age category, would provide direction to athletes and coaches that is generally not available in current programs.

Specialization by Sport and Position. The practice of involving children in sports at an early age, keeping them involved in that sport for the greater portion of each year, and restricting them within that sport to one position or event may produce a few Olympic caliber athletes, but it is far more likely to result in negative consequences. Children should be encouraged to learn the fundamental skills in a variety of sports and they should be encouraged to experience the skill and cognitive requirements of many positions. The likelihood of a child spending an entire competitive lifetime at a position within a sport that was learned at age 6 is remote; but the possibility of that child at a later age using some skills learned during childhood but within a variety of sports is much more likely.

Summary

Chronological age, the most commonly used criterion in classifying children for athletic competition, produces much of the inequity that exists in age-group competition. The important variables of body size, skill level, experience, and biological maturation must be considered if the opportunity to strive to win is to remain an important objective in children's programs. Although the effects of athletic competition on the physiological and psychological development of children is

neither clearly nor wholly understood, experience has allowed us to identify certain undesirable practices, and to recommend procedures that will bring about the positive results much hoped for by the protagonists of children's sports.

HOW DO CHILDREN PERCEIVE THE SPORT EXPERIENCE?

Jerry R. Thomas
Jere D. Gallagher

Current estimates are that approximately 20 million children participate in sport in the U.S. Comments are frequently heard about the value of sport and related exercise for these children. While the immediate exercise benefits from sport experience is certainly of tremendous value, we should be even more concerned about how children perceive this sport experience because this perception is ultimately the major determinant of continued participation in sport and regular exercise.

What do we really know about how children perceive and interpret their experience in sport? Do kids perceive the events and outcomes of sport contests the way adults do? Evidence from research suggests two important factors about kids in sports: first, while much of the sport experience is positive, coaches and parents may inadvertently be structuring some experiences which contribute to children "dropping out" of sport; and second, the literature on how young children learn contains considerable evidence that they may not process all the available information in many situations as older children and adults do. This fact will affect their perception of events. Please note: in this paper we will discuss children's PERCEPTION of the events that occur to them and others. This perception of events may vary from one child to another (or from one adult to another), and may not be congruent with the actual circumstances.

Given an obvious cause for a behavior, both children and adults will attribute behavior to this cause. In fact, four rather common causes of behavior (ability, effort, task difficulty, and luck) are used as the basis for attribution theory (Heider, 1958; Kelly, 1967, 1972). We see many examples of this attributional process in the comments of players and coaches following a victory or defeat. For example:

1. "our team is really loaded with talent this year" (ability)
2. "the girls really played hard" (effort)
3. "the other team just had too many skilled players" (task difficulty)
4. "gee! every bounce went against us" (luck).

There is considerable evidence to support the view that children and adults use factors such as those just listed, to make decisions about engaging in competitive situations as well as in explaining the outcomes of these situations. That is to say: when confronted with sport competition, children assess the situation as they perceive it, evaluate their ability, the difficulty of the task, how much effort is needed, compare the

prospect with past experiences, and decide whether to attempt the particular task or not. If they decide to attempt the task, then the most appropriate behavior is generated. The child then evaluates the outcome (or is helped to do so) and ascribes the results to some combination of ability, effort, task difficulty, and luck. This information is then stored in memory for use in similar future circumstances. When ascriptions threaten our self-esteem, we employ an ego-defensive mechanism referred to as "self-enhancing" behavior (Feather & Simon, 1971; Wortman, Costanzo, & Witt, 1973). That is, after a loss a player has a tendency to suggest that the other performers on the team did not give much effort during the game, but that he/she gave a lot of effort (Roberts, 1975).

Over time, children are led to ask the basic question, "Am I in control of what happens to me?" If coaches and parents adhere to the normal objectives of education and development, their purpose is to move children from dependence to independence through the child's everyday experiences. Thus, we hope that children will perceive themselves as in control of their lives (internal) rather than having circumstances controlling them (external).

Do typical sport experiences develop this feeling of internal control? We must admit that our experiences show that most of the events in sport for children are organized and controlled by adults. The coach typically organizes all aspects of the practice and the game. Even the game times are frequently set for the convenience of adult attendance rather than in the best interest of children.

Just a reminder, if this sounds as though we find all sport experiences for children negative, we don't. Our purpose is to point out some of the problems that theory and empirical research suggest are valid. We believe that sport is a positive experience in children's lives. Our goal is to make that experience better so that more children will participate and continue to participate on a life-long basis.

Why so much concern about the factors previously mentioned? Because we believe that children should participate in sport and regular exercise; yet if the results of a recent survey in Michigan (Seefeldt, 1976) can be generalized to the entire country, we find that as many as 80 percent of children drop out of sport (percentages vary by sport) between the ages of 12 and 17. Certainly, the problems previously discussed are not solely responsible for this drop-out rate, although they may be important factors.

Children should be and are intrinsically motivated to participate in sport. Their enthusiasm is obvious on the playing fields and gymnasiums. Yet this enthusiasm wanes as they grow older. Do we contribute to this loss of intrinsic

motive by the way we organize and conduct the sport experience? Consider the following:

1. How does an audience affect the interest and motivation of a poorly skilled player?
2. What does the coach's strategy in using a poorly skilled player only in circumstances when the game is clearly won/lost, do to the player's self-image?
3. Do all the awards in sport increase the motivation of players? Does it depend upon their skill level age?
4. Will players who are "cut" from teams continue to have positive motivation?

We suspect many of the above situations (and others) decrease rather than increase intrinsic motivation for sport and regular exercise.

In the review that follows, we attempt to focus on two aspects of children's sport, namely, winning/losing and awards. Our purpose is to suggest that considerable evidence is available concerning these two factors and their influence on children. Further, we are trying to point out that younger children do not process information in exactly the same way as adults. This fact must influence their perception of events and should be considered by coaches, parents and other educators.

Outcomes of Sport Contests

If children consistently face losing or winning situations, causal ascriptions differ for current outcomes, future expectations and continual task persistence (achievement motivation) (Daughdrill, 1978; Iso-Ahola, 1977; Roberts, 1975). Daughdrill (1978) and Roberts (1975) found that participants use a self-serving strategy when causally attributing outcomes to themselves, but adopt a logical information processing approach when attributing outcomes to teams. Iso-Ahola (1977) found that players used the standard of team performance as the criterion for self-perceived behavior.

Players in consistently losing situations believed they were low in ability, exerted less effort, faced a more complex task, and considered luck to be an important factor. In opposition, consistently winning teams that lost did not differ much from the winning teams that won except in that their team attributions ascribed decreased effort on the part of team members with a strong effort of the individual (Daughdrill, 1978). Additionally, the consistent winners that lost attributed the outcome to occasional bad luck and increased task difficulty.

Consistently experiencing winning or losing affects the expected outcome of children. Obviously, consistently winning teams, no matter what the current outcome, expect to win in the

future. A consistently winning team that loses ascribes performance to unstable factors (bad luck, increased task difficulty) and expects to experience future success. Consistently losing teams that currently win attribute winning to unstable factors (good luck, increased effort) and they do not expect to win in the future. Expectation of experiencing future failure is the belief of the consistently losing teams.

Ascriptions for consistent winners and losers may produce behavior characteristics of high or low achievement oriented behavior. Persistent failure is related to low achievement behavior which elicits a desire to terminate participation, while continual success is related to high achievement behavior and the desire to continue participation and try harder (Scanlan, 1978). Scanlan (1978) proposes that those children deemed consistent losers might profit from the situation if given support from significant others (parents, coaches, peers). Children who continually receive negative comparative appraisal but receive support and guidance from their parents and coaches might benefit considerably from the competitive experience. With support, these children might learn to accept their limitations and capabilities and learn to function realistically, thus developing the ability to set and strive for realistic goals as well as coping with success and failure.

Differences in Males and Females. Until recently, differences in young males and females regarding ascription of winning and losing in sport had not been studied. Daughdrill (1978) determined that with increasing age females attributed successful outcomes to external causes and unsuccessful outcomes to internal causes, whereas males attributed successful outcomes to internal causes and unsuccessful outcomes to external causes. It is significant that with increasing age the female players attributed winning more to luck while exerting less effort, with the opposite holding true for the males. Consequently, with increased age, females attributed successful outcomes more to external factors (luck) and considered themselves as exerting less effort (internal factor). Elucidation of this finding was apparently due to societal pressure for sex role development (Fontaine, Note 1).

Effects of Aging. Roberts (1975) and Iso-Ahola's (1977) subjects were not divided into age groups for analysis purposes. Daughdrill's (1978) study, however, utilized eight-, ten-, and twelve-year-old subjects. Although they were unable to render conclusive support for age differences in attributing winning and losing, a trend of the data was noted. Regardless of past experiences and outcomes, the younger players were more confident that they would win the next game played. The differences in future expectations for past winners vs. past losers expand as the child gets older. Children in all age groups and both sexes, that were consistent winners, expected to win the next game. Yet 8 year old females who were consistent losers still thought they would win the next game. The lack of strong support for age differences suggests that

the processing capacity of eight-year-olds may not have been taxed by the attributional process. Additionally, it appears that consistently losing males that won did not consider past outcomes and, therefore, did not have the full extent of information to process.

In summary of the effects of the outcomes of sports contests on children's attributional processing, it appears that children must selectively attend to task appropriate cues, recall past experiences, evaluate expected outcomes in relation to actual outcomes, and make attributions concerning future expectations. Consistent winners tend to attribute winning to internal factors (increased ability and effort) causing heightened task persistence, while consistent losers attribute losing to internal factors (decreased ability and effort) and may tend to drop out of sport. The data from one research study (Daughdrill, 1978) lends support to the differences existing between males and females. Females attribute winning more to external causes and males to internal causes. The possibility exists that this difference is due to cultural pressure on the females. Additionally, Daughdrill (1978) investigated attributional processes developmentally with a lack of complete support for age differences. However, some support was provided for the idea that younger children failed to use all the task relevant information to determining future expectations. Some additional research into this processing deficits hypothesis (Chi, 1976; Thomas, 1980) with regard to attributions about winning/losing is needed.

Rewards in Sport

Posited in an attributional framework, the hypothesis concerning receipt of rewards in athletics would be the overjustification effect (Greene & Leppter, 1974; Lepper, Greene & Nisbett, 1973; Lepper & Greene, 1975) causing undermining of intrinsic motivation. This effect has been found in cognitive activities (Karnoil & Ross, 1975; M.Ross, 1976), naturalistic play activities (Greene & Lepper, 1974; Lepper, et al., 1973; Lepper & Greene, 1975), puzzles (Deci, 1971, 1972) and physical skills (Halliwell, 1976; Thomas & Tennant, 1978). Generalization of rewards undermining intrinsic motivation has been demonstrated to carry over to college athletics. Ryan (Note 2) found that older scholarship athletes in college viewed their athletic participation as being less enjoyable than their non-scholarship counterparts.

However, rewards to athletes can act as information concerning the performance of skills or abilities of the individual if given contingent to the quality of performance (Lepper & Greene, 1976; M. Ross, 1976; Thomas & Tennant, 1978). This will result in an increase in performance and motivation. The reduction of intrinsic motivation from rewards (not contingent upon the quality of performance) acting as a bribe might cause the loss of a feeling of being in control, while contingent rewards render information regarding performance. Youth sports leagues frequently give each team member,

regardless of the quality of play, certificates or trophies. The youngsters receiving these rewards may view their reasons for participating as being to obtain the reward and not for self-enjoyment. Thomas and Tennant (1978) have stated that it is important for the child, when receiving a performance contingent reward, to feel qualified to receive such a reward. If the reward is contingent to performance but the child does not feel capable of achievement, then intrinsic motivation may be undermined. For instance, even though the "Most Valuable Player" award is contingent upon the quality of performance, how many players actually feel they have a chance to earn this reward?

A discrepancy has been noted concerning the age at which rewards undermine intrinsic motivation in self-perception and other-perception studies. Halliwell (1976) suggested a developmental continuum ranging from information regarding oneself in a naturalistic setting (self-perception), which would be the least complex to process, to description of other people's behavior (other perception) from an audiotape, which would be the most difficult to process. Since youth sports mainly involves the children's perception of their own behavior in a naturalistic setting, that is what we will consider. Greene and Lepper (1974), Lepper et al. (1973) and Lepper and Greene (1975) found that in a naturalistic play setting, five-year-old children's motivation was undermined by extrinsic rewards. Thomas and Tennant (1978), using a physical skill, found that rewards for five year olds increased the time at target activity. Differences in explanation were noted due to several viable methodological differences. Regardless of the age at which undermining occurs (Halliwell, 1976; Karnoil & Ross, 1976), increasing age results in greater amounts of discounting in non-contingent reward situations (self-perception: Thomas & Tennant, 1978; other perception: Halliwell, 1976; Karnoil & Ross, 1976). By age seven, no differences in motivation can be found between the control and reward groups. By nine years, however, all children view the non-contingent reward as a bribe to participate in the task which seriously undermines the persistence in a free choice situation.

These findings fall in line with developmental information processing theory. The younger child is unable to hold in memory the information necessary for the rewards to be perceived as a bribe. However, since the use of control strategies increase with age, older children become able to process the information with regard to the reward, their motivation, and past experiences with rewards. They then perceive the reward as a bribe to participate which provides a sufficient cause to attribute the reason for participating, i.e., intrinsic motivation is reduced.

Implications for Parents, Coaches, and Educators

Most importantly, we cannot treat children as miniature adults regardless of the type of behavior (cognitive, affective, or psychomotor). They process the events in their world differently, resulting in differences in the perception of the causes of these events.

The outcome of an individual game has a limited influence on the child's perception. However, outcomes that are consistent over time do influence both current attributions and the child's future expectancy, especially in older children. This effect is most disturbing when children are placed on teams which lose consistently. The result is that the child begins to view himself as low in ability and expects to lose in the future. It also seems that the child adopts the self-protecting mechanism of giving less effort during future contests. This allows the rationalization of "I really didn't try very hard, so it's not so bad to lose." Surely we want to avoid ascriptions of low ability and expectation to lose in the future because of poor effort. Our speculation is that, taken together, these factors result in less enjoyment of the sport situation and increase the likelihood that the child will cease to participate. Of course, if the study we have available on girls (Daughdrill, 1978) is correct, the effect is even more pronounced for them. The effects of consistently losing seem to increase with age.

What can we do? Aren't games either won or lost? How do we control this? Several alternatives have been suggested elsewhere (Thomas, 1978). However, the most pertinent factor is to recognize that "game outcome" may not be the most important consideration in children's sport. We believe that several other considerations are of more importance. The key technique is to employ an effort-ability question that is self-directed: "Did I try my best and do better than I have previously?" Coaches and parents need to focus children's perception on this question. It is an internal (Am I in control?) question.

Individual sports (swimming, track and field, gymnastics) can easily be focused on past performance. Why not conduct a meet where the individual and team score is based on comparisons made of athletes with the average of some previous number of their own performance? We don't mean to suggest that this is the only acceptable form of comparison and scoring. But why should comparison with others be the only valued measure?

Another consideration in age group sports (individual, dual, team) that affects contest outcome is team composition. We see very little long-term value to the fact that traditionally all children are kept on the same team. Some system to rotate children among teams during the season does not affect individual contest outcome but does solve the

problems associated with consistent winning/losing which is the factor that seriously alters attributional patterns.

This raises the whole issue of league/city/state/national champions. Why is it important to establish who won the league/city/state/national championship? Perhaps the more relevant question might be, "To whom is it important?" To children? We doubt it. "To parents and coaches" seems the appropriate answer. The question then becomes, "Shall we cause the problems children develop from consistently losing so parents and coaches can determine who's Number One?"

The second consideration of importance in the literature presented dealt with rewards. Nearly everyone we know in children's sports believes that rewards have assumed too much importance. The literature supports the fact that rewards not based upon the quality of the child's performance undermine intrinsic motivation. The child begins to perceive himself as performing in order to obtain the extrinsic reward. While rewards based on the quality of the child's performance increase intrinsic motivation, many of the so-called performance-based rewards in sport are available only to the outstanding performer. Surely average players on a team recognize that they have no chance to obtain the "most valuable player" award. So for practical purposes, it seems unlikely that this award will increase intrinsic motivation for most children. We believe the problem becomes particularly acute in individual sports like swimming and gymnastics where a child may earn several hundred medals and trophies over a two-to-three year period. The value of this number of awards to anyone is questionable.

Truly, we don't know where to set the limits on awards. Certainly they should be reduced considerably (particularly in individual sports) and they should carry special meaning when given. The best example we know is the banana award (Thomas, 1978). The coach wrote the title of the award and the boy's name on the side of a banana. He called the boy up in front of his peers and parents and presented the banana. Then he had the boy peel and eat the banana right on the spot. The point is clear: success in sport is like a banana, you have to earn it fresh every day. If you try to keep what you had, it goes rotten.

Sport is neither inherently good nor bad. The people who conduct sport make it a positive or negative experience for children. We believe all the people involved in children's sport want to help kids. We also believe they inadvertently do some things thhat reduce the enjoyment kids find in sport and their enthusiasm for sport. Certainly, by raising some questions that have been voiced by many, reviewing theory and research on these questions, and suggesting some alterations in practice for those controlling sport, the positive experiences for children can be increased.

NEUROPHYSIOLOGICAL CORRELATES OF MOTOR DEVELOPMENT: A REVIEW FOR PRACTITIONERS

Harriet G. Williams

Efficient or skillful motor control requires that the child perform a variety of sustained muscular contractions which are accurately controlled in both force and extent as well as appropriately organized in time and space. This means that if the child is to be skillful in catching or striking or cutting or pasting, appropriate groups of muscles must be selected to be included in the movement as well as in the posture that supports the movement; contractions of these muscles must be precisely organized temporally and spatially; and the degree of contraction must be regulated so that an appropriate amount of force is produced (Glencross, 1978). This is no simple task even for an adult. Those of us who work with young children are aware that such processes are more easily talked about than they are carried out by the child who is learning to move skillfully.

Although the above processes represent important neurophysiological phenomena which help to explain why children move as they do, we have heretofore paid little attention to them because we have believed that they held little significance for the practitiioner who was interested in developing or remediating basic motor skill patterns in young children. Increased knowledge about neuromuscular functioning and the development of sophisticated techniques to record electrophysiological events in motor activity have enabled us to describe the nature of selected electrophysiological phenomena of motor control and to note the changes that occur in such phenomena with development and training. Such information provides important guidelines as well as needed foundational support for the building of sound programs and practices in motor development for young children. Thus, following a brief discussion of what we know about developmental changes in electrophysiological phenomena accompanying motor activity in young children, I will focus on the implications of such information for promoting motor development and motor learning in young children. The intent is not to describe "how" to teach but rather to bring forth some long-needed scientific support for establishing general guidelines for motor development programs.

Neuromuscular Control: Force Production

It is important to note that one of the primary factors contributing to efficient gross and/or fine motor control is appropriate force production. To perform a task skillfully, "X" force is needed--no more, no less. Recent research has shown that one of the first things learned in mastering a motor task is to generate force in direct relationship to that needed

to perform the task (Glencross, 1978). This is true in adults and children alike. This change in force regulation, which comes with practice, is typically seen in the form of decreased tension and/or extraneous activity of non-involved limbs or body parts. This is an important adjunct to a natural, smooth, free-flowing pattern of movement.

Evidence from recent EMG studies of young children's performance on a variety of balance tasks clearly shows that younger children tend to generate more force than needed in those muscle groups used to establish and maintain balance (Shambes, 1976). Older children generate much less force and show considerably less EMG activity in all muscle groups involved. It may be that the neuromuscular system of the young child tends to respond to movement demands within the environment with a more general all-out effort.

One of the mechanisms by which increased force production occurs is synchronized motor unit firing. Usually, during voluntary muscle contraction, motor units, the major functional element of the muscle, tend to fire independently of one another. However, under conditions which require greater force of muscular contraction, some overlap in the timing of the firing of motor units (synchronization) seems to occur. The net effect of this near simultaneous firing of motor units is an increase in the amount for force produced by the muscle contraction. Milner-Brown, et.al.(1975) have reported data that suggest that changes in the timing of the firing of single motor units is a direct result of a regular use or training of muscles. They clearly showed that individuals who had practice in performing selected movements over a period of time had significantly higher synchronization ratios than did individuals who had not practiced those movements before. The effect of guided practice was a change in the timing of single motor unit firing. Even more important than this, these authors showed that changes in supraspinal connections or pathways from the motor cortex directly to spinal motor neurons provided the foundation for the significant increase or change in timing of motor unit firing. These observations clearly suggest that one of the benefits of training or practice is a strengthening of reflex sensorimotor pathways to and from the cortex--a process which helps to refine force characteristics of the movement and thus leads, in turn, to more efficient task performance.

Broadly interpreted, observations from both Shambes (1976) and Milner-Brown, et.al.(1975) suggest that it is through experience and training that important changes in the neurophysiological mechanisms which subserve force-production characteristics of skillful movement occur. Thus, one might assume that the enormous amount of time spent in trial-and-error practice by the young child is indeed integral to the development of the neurological mechanisms which underlie the ultimate control and refinement of motor skill; that the child needs this "experimenting" time to refine the

basic force/strength parameters of the movement. Since practice and repetition of a movement pattern does contribute to important neurophysiological and neuromuscular changes which subserve further skill refinement, we need to provide for both guided and free practice of movement patterns in and out of the school setting. We need especially to be aware of the importance of providing appropriately broad and well-organized programs of movement experiences that will help to contribute to the full development of these mechanisms of force production and ultimately of motor control.

Shambes (1976) provides some further insight into the kind of changes that occur in neuromuscular mechanisms as the young child grows and matures. She studied the nature of the EMG patterning involved in assuming and maintaining several different balance positions by 4 and 8 year old children. The balance positions included: balancing on elbows, balancing on all fours, kneeling, half kneeling, and erect standing. Some informative and enlightening differences were observed in the way 4 and 8 year old children achieved these different balance positions. For example, although the body position that the 4 and 8 year olds assumed in achieving the "on elbows" position looked the same, the covert muscle activity in the two groups of children was quite different. In general, the 4 year olds seemed to involve slightly different muscle groups and more of them to maintain balance in this position. These children also evidenced higher levels of activity (higher EMG amplitudes) in the muscles involved in maintaining balance than did 8 year olds. These same differences were noted for the "all fours" position. Thus, although younger and older children tended to look very much alike in their overt body or balance positions, there were important and identifiable differences in the means by which the neuromuscular mechanism of the younger child achieved and maintained these balance positions.

Interestingly, in other slightly more demanding balance positions ("full kneel" and "half kneel"), there were both overt and covert differences. In both instances, younger children tended to have a more exaggerated forward tilt of the pelvis than the 8 year olds. Once again the younger children used more muscle groups and showed higher levels of activity in those muscle groups than did older children.

In contrast to both of the foregoing observations, the nature of the EMG activity involved in maintaining an upright stance was nearly identical in the two age groups. That is, both groups tended to use the same muscle groups to maintain balance in the upright position and both showed comparable levels of EMG activity in those muscle groups involved. These data suggest that when a motor task is relatively familiar and/or highly automated (e.g.,standing) there may be little or no difference between younger and older children in the way the neuromuscular mechanism acts to accomplish the task. This hints that with some practice in maintaining the upright

posture, both the younger and more mature neuromuscular system quickly establishes an appropriate pattern of control, one which efficiently prescribes the nature and degree of activity required to accomplish the familiar task of standing. However, when a task, even though it is relatively simple, is somewhat less familiar, less practiced (e.g.,balancing on "all fours," "full kneel"), the neuromuscular mechanism of the younger child acts in a much less adaptive way to perform that task. This inefficient adaptation is both qualitatively and quantitatively different from that of the older child; it is qualitatively different in that different muscle groups are used by the young child; and quantitatively different in that more muscle groups are used to a greater degree by the young child. Overall this suggests that a different and more efficient pattern of neuromuscular control is used by the older child to adapt or accommodate to unfamiliar situations. This more effective adaptation of the body's musculature to previously unexperienced situations may be one of the most important benefits of added experience and training that are part of participation in motor development programs. Could this be one aspect of the neurophysiological substrata of the old adage that "practice makes perfect"?

Simard (1969) has provided some important information about the ages at which changes in neuromuscular control, from an electrophysiological point of view, may occur. Simard (1969) studied the ability of young children (3-12 years) to control voluntarily the activity of single motor units in a specific muscle group, the rhomboids. He reported that when given the opportunity to experience (e.g., see, hear, feel) the results of various degrees of contraction and relaxation of the rhomboid muscle, children of all ages (even the 3 year olds) were able to control the activity and rest of single motor units for at least 10 minutes. In fact, not a single one of 51 children was unable to develop some degree of fine neuromuscular control of this kind. This, of course, clearly indicates that there is a great deal of capacity for fine differentiation and control of neuromuscular mechanisms involved in motor learning even in the very young child. Thus, programs focusing on movement experiences for the young child can be effective.

Simard (1969) does report some important age differences in the ability of the children to maintain control of the firing in single motor units. Younger children (3-6 years) in particular were inconsistent, erratic, and required constant reminders to "re-isolate" the activity in the motor unit on which they had been trained. Older children (8 years) were more consistent in maintaining this single motor unit activity. Even more interesting, for the majority of children who were successful in developing this control, continued practiced at such control enabled them to transfer control to other motor units within the same muscle--often with as little as five minutes of practice. The process, once learned, seemed to transfer easily to other motor units.

These same children were asked to superimpose an ipsilateral, sequential limb movement (taking a drink of water) on activity already ongoing in a single motor unit in the rhomboid muscle. Simard (1969) refers to this as "dynamic fine motor control"--doing two things at once. Three year olds were unable to demonstrate this form of neuromuscular control. Some 4, 5, and 6 year olds were able to develop this control, but the percentage of success was very low (33%). Not until 7, 8, and 9 years of age were the majority of children able to consistently maintain control over single motor unit activity when another movement was performed simultaneously. There was little or no change in this ability after the age of nine.

These data suggest that important refinements in the young child's neuromuscular mechanism may occur between the ages of 4 and 9 years, and that particularly dramatic changes may take place during the 7-9 year period. Motor development experts recognize this latter period as a time of rapid growth in both acquisition and refinement of more complex skills for boys and girls. It would not seem unreasonable to speculate that the dramatic changes that we see in overt motor behavior of children during this period of time may be a manifestation of the increased capacity of the neurophysiological mechanisms underlying motor control to successfully superimpose new movements on the framework of other already ongoing movements. It is interesting to note that the age at which children first demonstrate the ability to perform this kind of complex motor control function (3-4 years) coincides with a period of rapid growth of cerebellar function.

The implication for the teaching/learning of motor skills in early years seems clear. We should (must) capaitilize on the changes that are occurring in the mechanisms underlying motor development during this time by providing the young child with regular and ample opportunity for movement experiences that will help to promote the growth of motor control mechanisms to their ultimate potential. Further, these observations may help us to begin to define scientifically the time constraints which encompass the "critical years" for motor skill development.

Building on the studies of Shambes (1976) and Simard (1969), Williams, et.al. (1978) have compared patterns of EMG activity in 4, 6, and 8 year old normal and learning disabled children. The specific question asked was: What happens to the EMG activity in those muscle groups that act to maintain the body in a specific body position when a young child is asked to perform a manipulative act (e.g., writing, cutting, pasting, or holding a bat)? In other words, how efficiently can the young child maintain a given postural framework when a movement of the arm is superimposed on that postural framework?

Data gathered on 40 children suggest that the EMG patterns for younger children revealed a much greater and more widespread EMG response in muscle groups involved in simply maintaining posture than was true for older children. In addition, it appeared that a much greater change in terms of selective use of muscle groups (both in numbers and level of response) in maintaining balance occured between 4 and 6 years of age than between 6 and 8 years. Six year olds showed much less widespread EMG responses in posture maintenance than did 4 year olds. Differences between 6 and 8 year olds were minimal. It may be that the early years (4 to 6) are critical to the development of basic muscular control of posture; if so, the focus of activities in movement programs for the young should be on the development of such postural or balance mechanisms.

When a manipulative movement is superimposed on an assumed postural framework, the response of the neuromuscular system is very similar for both 4 and 6 year olds. The systems of both of these younger groups respond with far more widespread and higher levels of EMG activity in involved muscle groups than is true for 8 year olds. This suggests that younger children (4-6 year olds) are not capable for superimposing movements on a given framework of support without excessive reaction of the neuromuscular system. Eight year olds, however, seem to be able to do this without interrupting activity in the mechanism underlying postural support for movement. These data hint that the period from 6-8 years may be an important one for the development of control of more complex motor activity. The fact that these observations are corroborated by those of Simard (1969) strongly suggests that the period for 4 to 8 or 9 years of age is a significant one in terms of the development of neurophysiological mechanisms underlying both postural and dynamic motor control.

Neuromuscular Control: Learning Disabled Children

What about the learning disabled child who frequently displays significant lags in motor development? Data from the Williams, et.al.(1978) indicated that EMG patterns for the learning disabled child showed (as with the young child) a much greater and more widespread electrophysiological response to the maintenance of posture than was true for normal children of comparable chronological ages. Even more important, when a simple manipulative movement was superimposed on this postural framework, the neuromuscular system of the learning disabled child did noticeably more work in accommodating the added movement than that of the normally developing child. Thus, not only was the maintenance of balance and/or equilibrium of the body more inefficient and taxing for the learning disabled child, but any adjustment of the body's postural framework to accommodate additional movements of the extremities was also more difficult. It would appear that the neuromuscular development and function of the so-called learning disabled child may be more comparable to that of the chronologically

younger child. Consider this in relation to the whole repertoire of complex motor skills and postural adaptations that we expect these children to make every day at home and in school. Many learning disabled children struggle constantly to have even moderate success in mastering motor-based tasks that are readily accomplished by their normally developing age-mates. Furthermore, if this neuromuscular deficiency is coupled with other perceptual, behavioral, and/or language problems, such inadequacy could and probably does contribute significantly to the total range of learning and behavioral problems that this child faces.

The learning disabled child, then, especially needs to have regular guidance, help, and opportunity to learn and to practice muscular contraction and relaxation, to learn to isolate the use of various muscle masses of the body, and, above all, to experience the whole range of force-production characteristics of movement from "zero" force-production (relaxation) to maximal force production (explosive running, jumping and throwing). I know of no other way to effect the changes that are needed to develop adequate motor control in young children, learning disabled or otherwise, than to have them use, experiment, and experience the moving of their bodies in as accepting and secure an environment as possible.

Neuromuscular Control: Inhibition

Neuromuscular inhibition is an important aspect of the development of motor control of young children. Neurophysiologists agree that there are two processes that are important to motor control in both children and adults: excitation and inhibition. In general, in muscular contraction accompanying voluntary motor acts, excitation of agonists (muscles responsible for movement) is preceded by inhibition of antagonists (muscles that must relax if the movement is to proceed smoothly). During these same voluntary movements, inhibition may also occur in the agonist. Thus, in flexing the elbow, activity in the triceps muscle is inhibited prior to the start of the movement. Following this inhibition, excitation of the biceps (agonist) occurs. Immediately before the end of the flexion movement, activity in the biceps may be inhibited to help in stopping the movement at the appropriate point. These excitatory and inhibitory processes subserve voluntary muscle contraction and contribute in important ways to the refinement of motor control. Antagonist and agonist inhibition are important because they help to reduce the amount of energy needed to perform a given movement. The timing of antagonist and agonist inhibition is important because errors can affect both the starting and stopping of the movement and thus contribute to the production of jerky, uncoordinated movement.

The ontogenesis of inhibitory processes and the course of their development in children provides insight into the nature of the problems the young child faces in mastering motor

skills. Gatev (1972) has reported some interesting observations about the development of such neurophysiological processes in infants and young children. He studied three age groups (infants 1-2 months, infants 7-9 months, and children 2 1/2 to 3 years) and recorded EMGs in biceps and triceps muscles of these children while they lay in a prone position and performed various reaching and grasping behaviors. He identified three basic patterns of excitation/inhibition activity: a) simultaneous inhibition, where antagonist inhibition and agonist excitation occur simultaneously; b) delayed inhibition, where antagonist inhibition occurs after agonist excitation and c) anticipatory inhibition, where antagonist inhibition occurs before agonist excitation (the mature pattern).

In general, for most 1-2 month old infants, there was little or no inhibition of antagonist muscles of any kind. Interestingly, in these 1-2 month old infants, the excitation of the agonist was also reduced. Thus, an easy transition from flexion to extension and vice-versa was not possible for most 1-2 month old infants. Although there was some evidence of delayed or simultaneous inhibition of the antagonist in a few infants this age, anticipatory inhibition (the mature pattern) was never seen. It should also be noted that when delayed or simultaneous inhibition was present, it was never complete; there was never a total cessation of antagonist activity. This suggests that in the very young child contraction and relaxation of muscle groups contributing to the performance of a movement are not easily regulated and, in fact, such processes may actually interfere with one another. Such interference may be manifested in jerky, unrefined, uncontrolled movements which are characteristic of reaching, grasping behaviors of infants that age.

In contrast to the very young infant, antagonist inhibition of some kind was seen in approximately 25% of 7-9 month olds. The predominant form of inhibition observed in these infants was either simultaneous or delayed. Some evidence of anticipatory inhibition was also present in the EMG patterns of many of these 7-9 month old infants. The stage of development coincides with the time when reaching/grasping behaviors of the infant are undergoing dramatic improvements. As with the young infant, however, all inhibitory processes were incomplete and led only to a small reduction of activity in the antagonist muscle and never to complete cessation of activity in that muscle. For 2 1/2 to 3 year olds, antagonist inhibition of some kind was recorded in over 80% of the children studied. In 75% of the cases, anticipatory inhibition was the dominant form of inhibition, and inhibition of the antagonist was always more complete and longer lasting than in younger infants. This change in neurological events (the consistent presence and change in timing of antagonist inhibition) suggests that motor control mechanisms of the 3 year old are undergoing some important changes, and that the system of the 3 year old may be rapidly approaching the more mature or adult pattern of

functioning in terms of reaching/grasping behaviors. This is, of course, strongly reinforced by behavioral observations of basic eye-hand coordination performances of 2 and 3 year olds. They have made gigantic steps forward when compared to children 9-12 months old.

With regard to agonist inhibition, in no instance was this phenomenon observed in children under 2 1/2 to 3 years of age, and only 10% of 2 to 3 year olds showed definite recognizable agonist inhibition. Even for these children, agonist inhibition was sporadic and incomplete. These data suggest that the adult pattern of neuromuscular functioning is still not fully established in the 3 year old child and that further refinement of the neuromuscular mechanism will occur during pre-school and early primary years.

Summarizing Gatev's (1972) observations, what we see is that the immature neuromuscular system controls movements without the benefit of well defined inhibitory processes (0 to 9 months); in the growing, developing system, inhibitory processes are better expressed but still immature and so may interfere with efficient motor control (2 to 3 years). In the mature system, inhibitory processes are clearly articulated and help to provide the foundation for effective and precise control of movements. Thus an important part of the motor development of young children may be the appearance and timing of inhibitory processes involved in muscle contractions. Since agonist inhibition is the last of the inhibitory phenomena to appear developmentally (it cannot be elicited consistently in 2 to 3 year olds), it most likely represents the refinement of higher levels of motor control. At present, it is not known when inhibitory processes involved in neuromuscular control do become mature, but it is not unreasonable to suspect that this process continues to be perfected throughout early and middle childhood. This may provide a partial explanation for the continued refinement in fine-motor skill development that is observed during the later elementary school years.

Summary

All of the studies reviewed clearly indicate that important neurophysiological changes take place in the mechanisms underlying motor development during the period from 3 to 9 years (early and middle childhood). These changes are undoubtedly intricately related to the behavioral changes observed in the child's rapidly expanding motor behavior repertoire during those years. Such developmental changes represent important milestones in the coming to maturity of the neurophysiological mechanisms of motor control. Perhaps the greatest significance that these neurophysiological growth processes have is that they may be a direct indication of the "critical years" for optimum motor development in young children. Creative, semi-structured and thoughtfully planned programs of motor development thus would seem to be important for all children during these years, for this is a time when

motor experiences (e.g., opportunities to practice and/or learn motor skills) both affect and are affected by the nature of the changes taking place in underlying neuromuscular processes. From a neurological point of view, the following may be important guidelines to use in working with young children in motor devlopment programs:

1. programs should focus on children from 3 to 9 as these seem to be the years when important changes are taking place in the neurophysiological mechanisms which underlie the development of motor skills;
2. motor development programs need to be broadly based (e.g., provide as wide a range of movement experiences as possible); loosely structured (e.g., allow maximum time for trial and error practice and problem solving experiences); and developmentally sensitive (e.g., heed differences in the neuromuscular maturation of children involved by providing maximum variation in movement experiences in secure and accepting environments); and
3. programs for younger children (4 to 6 years) might do well to emphasize activities which highlight balance and postural control while those for older children (6 to 9 years) might place more emphasis on complex fine and gross motor activities and/or combinations of the two.

It is especially important to remember that overt movement patterns are indeed an indirect reflection of the efficient functioning of underlying neurophysiological mechanisms, that a child cannot skillfully perform a motor task without adequate development of underlying neuromuscular mechanisms; that motor experiences can and do affect underlying neurophysiological mechanisms; and that practice and experience at age 3, 4, or 5 years helps to shape what the child is capable of doing, neuromuscularly, at 7, 8, or 9 years.

DEVELOPMENTALLY ENGINEERED EQUIPMENT AND PLAYSPACES FOR MOTOR DEVELOPMENT AND LEARNING

Jacqueline Herkowitz

The physical environment has an enormous impact on the development and learning of complex motor skills normally associated with sport and physical activity. Abundant evidence indicates that youngsters are highly responsive to the challenge of an appropriate environment (Dusenberry, 1952; Leithwood & Fowler, 1971; McGraw, 1935, 1939; Mirenva, 1935) and equally susceptible to the deprivations of an impoverished one (Dennis, 1935, 1938). Ripe periods for learning complex motor skills, which are largely a consequence of the normal maturation of the nervous system, the skeleton, and the musculature, occur throughout the preschool and elementary school years. Children who are provided with environmental opportunities to learn complex motor skills generally do so. On the other hand, when opportunities are limited or unavailable, complex motor skills are often poorly learned.

The majority of a child's motor education derives from informal play experiences in home and school environments. Such play experiences are predominantly interactions of the child with whatever equipment and apparatus the environment contains. Yet commercially available motor education equipment is rarely engineered for motor development and learning. More often than not, children are provided with balls that are too large and heavy to be properly grasped and thrown. Climbing equipment frequently demands performances that only children having the longest limbs and bravest perspectives can accomplish. It's common to see implements that are too narrow, too long, or too heavy to provide for successful striking performance. The learning of catching skills is often impeded by balls that are inappropriately small, heavy or fast. Finally, targets rarely provide information which can be used to adjust future performance. If playspaces for preschool and elementary school children are to provide opportunities for children to build a rich repertoire of complex motor skills, parents and educators responsible for the design of these environments need to select commercially available equipment and/or construct homemade equipment that:

acknowledges the nature of children's physical growth;
provides information about the motor performance;
encourages mechanically efficient movement;
acknowledges children's visual-perceptual information processing capabilities; and
provides for environmental novelty and complexity.

Accommodating Physical Growth Characteristics

Young children differ widely in growth status and growth rate with regard to weight, height, proportional growth of various body segments, skeletal ossification, distribution of fat and muscle tissue, postural characteristics, and somatotype (Lowrey, 1978; Malina, 1975; Sinclair, 1973; Tanner, 1978). Each child's potential for acquiring skillfulness in the performance of complex motor skills is limited and shaped to a significant extent by his or her unique configuration of growth characteristics (McGraw, 1939; Tanner, 1979). No two children are alike. For example, one child's center of gravity may be relatively high, making balancing more difficult and possibly limiting potential success in running, jumping, kicking, and climbing activities. On the other hand, another child's body proportions may enhance potential success in activities requiring balance. Playspaces must be designed to accommodate ALL children.

Research has suggested that the learning of sports skills by children may be facilitated by the use of lighter weight (Wright, 1967) or scaled down (Ward & Groppel, 1980) equipment. In addition, three equipment design strategies appear particularly successful in acknowledging the characteristically wide range of physical growth characteristics of children. The first strategy is to provide several pieces of equipment which are the same shape, but which differ in size. For example, three vertical ladders, each with rungs a different distance apart; three horizontal bars, each a different distance from the ground. For throwing: yarn balls of similar weight but different size; balls of the same size but different weight; suspended hoops with different diameters. Similar adaptations may be made for catching, striking, running, and jumping activities.

A second strategy is to provide equipment that children may change to accommodate their own growth status. Examples appropriate to throwing include: a small piece of black rubber floor matting with two yellow footprints painted on it, which children may move toward or away from the target; and a moving disk suspended on the end of a wooden rod which may be moved pendularly at different speeds. For jumping or leaping activities, a pair of hurdle standards and a plastic wand crossbar which children may raise or lower would be useful. Examples appropriate to striking activites include a ball which may be adjusted in elevation by means of an inverted hangman's noose from which it is suspended, and an adjustable batting tee with a funnel top. In similar fashion, equipment may be modified for catching, kicking, climbing and other activities.

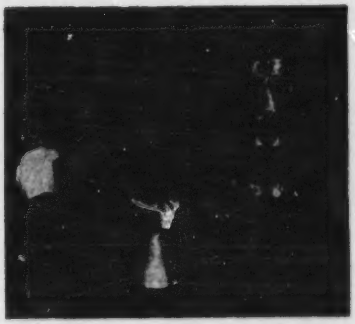
A third strategy is to provide equipment that incorporates gradual size gradations. An example for leaping and jumping activities is a long elastic cord fastened to the ground at one end and to a standard five feet from the ground at the other

end. For climbing equipment a horizontal ladder might be used in which the distance between the rungs gradually lengthens.

Facilitating Learning by Providing Knowledge of Results (KR)

It is well known that information about the acceptability and correctness of motor skill performance is critical to learning and performance. This KR may be a score presented verbally or mechanically to a performer as information about the outcome of the movement (Bilodeau, 1966; Brown, 1949; Holding, 1965; Miller, 1953). It is generally agreed that KR serves three functions: information, motivation, and reinforcement (Adams, 1971; Ammons, 1956; Bilodeau, 1966; Newell, 1976). It has been shown to maintain and increase interest in practicing, develop more accurate concepts about ability to perform, facilitate the monitoring of progress over time, and enhance communication between the learner and others regarding status and progress.

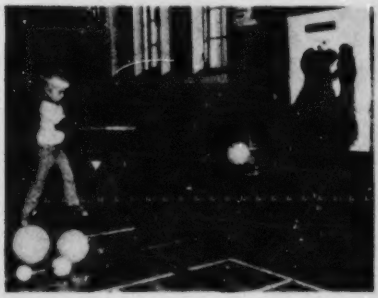
A number of techniques may be used to enhance the KR provided to the learner. Color may be used to provide KR: rope and vertical ladders with different colored rungs; lines of different colors at different distances from throwing targets; and sections of an inclined rope painted different colors. The same colors might be keyed to comparable levels of difficulty. Numbers, letters and words might be used: a jump and reach task in which the child must touch a piece of chalk to a progressively numbered piece of vinyl on the wall, or a rubber floor mat, for long jumping, where sections are identified alphabetically.



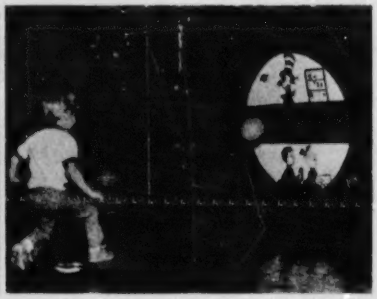
Sylvester and Tweety Bird Target

Hour Glass Timing Device

Timing devices may also be used, an hour glass timing device or a large clock with a single hand which is started and stopped by pressure sensitive mats. Another means of providing KR is through the use of sound. Examples include a sheet metal target or a stabilometer which buzzes when it is in balance. In similar manner, light may be used to provide KR.



Cookie Monster Target with Adjustable Batting Tee



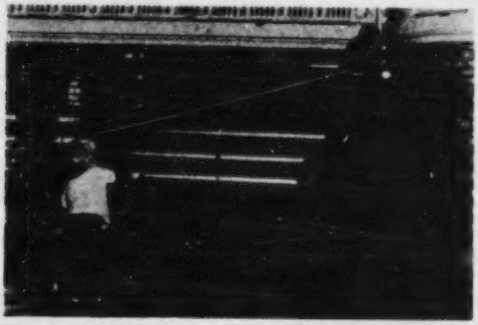
Space Ship

Children enjoy watching things move, hence the use of movement cues to provide KR will serve well. Examples include: a "Cookie Monster Window Shade Target" which rolls up when struck by a ball; a "Sylvester and Tweety Bird Target" made of two thicknesses of cardboard in which Tweety falls out of Sylvester's arms when struck by a forcefully thrown ball; and a "Dr. Suess Space Ship Target" which spins when struck. In similar manner, encapsulation is a means of providing KR. This involves designing targets which "capture" the thrown objects.

Facilitating the Acquisition of Ballistic Skills

Throwing, striking, and kicking stationary balls at targets are complex motor skills which are primarily ballistic in nature. A key to the successful design of appropriate apparatus for such activities requires recognition that effective force production is central to efficient performance of ballistic skills (McClenaghan & Gallahue, 1978; Wickstrom, 1977). Effective force production is influenced by the distance and size characteristics of the targets that are employed. Factors such as distance and size are critical. Targets must be far enough to encourage production of forceful movements and large enough so that the need for accuracy will not impede the production of force. Targets which are too small and too close seriously interfere with the ballistic character of throwing, striking, and kicking activities, since children will likely toss the ball rather than use a ballistic movement.

Employing targets which provide positive feedback only when desirable amounts of force and accuracy are produced facilitates the learning of ballistic skills. Windowshades that pop-up only when struck with sufficient force, and which can be adjusted to require more or less force, are useful. Another example is a "Bugs Bunny Target" whose teeth fall forward on a hinged support when struck with sufficient force and accuracy. Similarly, other devices which depend on force and accuracy to operate are useful, particularly if the amount of force and accuracy required can be adjusted to the skill and ability of the child.



Flower Target, Opposition Pressure Mat, and Neat Feet

Inclined Throwing Rope

Devices that encourage weight shift significantly contribute to performance efficiency. Painted footprints, placed appropriately, may be used to encourage weight shift. A pressure sensitive mat which activates a sound when stepped on will also remind the child to shift weight. It is also important to encourage the pelvic-spinal rotation, opposition, and sequential movement of body parts that are part of efficient striking, throwing and kicking performance. An inclined plastic rope, fixed to a basketball hoop and floor plate will encourage efficient performance as the child attempts to sling a foot long 2 inch diameter pipe up the rope toward a cymbal and colored markers. Efficient movement may also be encouraged by using a plastic ball inside a mesh bag

which hangs from a piece of sash cord strung parallel to the ground and slightly above the head level of the child; the task here is to strike the ball over the supporting sash as many times as possible.

Suspended Plastic Ball in Net and Neat Feet

Further considerations for throwing, striking, and kicking activities include: the use of adjustable supports and other devices that do not interfere with the natural trajectory characteristics of struck or kicked balls, e.g., adjustable batting tee, velcro fasteners to hold balls, and use of air jets to support foam balls; the length, surface area, weight, and grip characteristics of striking implements, e.g., lighter implements with larger surface areas which are easier to use, oversize bats, and smaller grip size; and the size, weight, and rebound characteristics of balls, e.g., progression from larger to smaller balls, lighter to heavier balls, and minimal to maximal rebounding balls.

Catching Net

Jumping activities are also ballistic in nature. Consequently, practitioners should identify different types of apparatus that will encourage the production of force in jumping. One example involves the child jumping toward an adjustable tin can target which will make noise when the child strikes it during flight. In this activity, as in all jumping activities, the landing surface must be such that it will partially absorb the force of impact to insure a safe landing.

Facilitating the Acquisition of Receipt Skills

Complex motor skills involving the receipt of projectiles include all catching, kicking, and striking skills in which a

performer is required to respond to a moving object. A key to the successful design of developmentally appropriate apparatus for such activities lies in sensitivity to the unique visual-perceptual information processing demands that the learning and performance of such skills makes upon children. Young and unskilled children appear less capable of: a) processing as much visual information; b) processing visual information as rapidly; or c) discriminating task relevant visual information, in receipt tasks, as compared with older and more skilled children (Connolly, 1970; Druker & Hagen, 1969; Gallahue, 1968; Hagen, 1967; Herkowitz, 1973; Ridenour, 1974, 1977; Vurpillot, 1968; Williams, 1968, 1974a). Consequently, successful receipt apparatus must incorporate ways of modulating the amount of visual information to be processed and the speed with which it must be processed. In addition, techniques for helping children more effectively discriminate key visual features must be incorporated.

The amount of visual information to be processed may be controlled by sequentially ordering the information to which children are exposed. The sequence should be: stationary balls; balloons (balls) dropped through the air; balls rolled along the ground; balls rolled down ramps; balls traveling in pendular trajectories; aerial balls; and balls bounced along the ground. The stationary ball is easiest since it does not move; a balloon dropped through the air travels slowly and consistently; a rolled ball travels progressively more slowly due to friction; a ball rolled down a ramp travels at increasingly faster speeds due to gravity. Balls moving in a pendular trajectory increase and decrease speed toward the bottom and top of the arc, respectively. Aerial balls present a more difficult and complex information processing task due to the effects of spin, wind resistance and accelerated speed. Finally, a bounced ball requires prediction of rebound and variable speeds since it increases speed as it leaves a bounce, slows at the top of the bounce, and increases speed once again as it drops to the next bounce.

Several examples for efficiently designed equipment to control the speed with which visual information must be processed may be cited. Large wooden, cloth, and net ramps adjusted in length, angle of inclination, and elevation enable the practitioner to control ball travel time and speed. Changing the size and weight of the balls used also affects the travel time and speed. As children become more skilled, the travel time may be shortened and the speed increased to intensify the information processing demands of the task.

The child's limited visual-perceptual discrimination capabilities can be accommodated by appropriately modifying the task. Performance will be enhanced by providing high contrast between the color of the projectile and the color of the background (Ridenour, 1979). A yellow ball traveling against a grey background is more desirable than a white ball against a white background. Additionally, the complexity of the

background must be minimized (Herkowitz, 1973). A solid colored ball against a background of a solid color is more desirable than a ball traveling against a background consisting of many colored geometric shapes. As the children become more skilled, the contrast and background requirements of the tasks may be made more challenging. Target movement characteristics should also be considered. Initially, targets should move from left to right, and right to left, in front of the performer. As skill develops, children should be given the opportunity to respond to targets that move toward and away from them.

Encouraging Activity Through Use of Complexity and Novelty

It appears that the amount of motor activity evidenced in a playspace over time is a function of complexity and novelty. Novelty appears to elicit responsiveness (Cockrell, 1965; Gilmore, 1966a, 1966b; Johnson, 1935; Mendel, 1965; Wuellner, 1969); and complexity appears to sustain interest (Cockrell, 1935; Gramza, Corush & Ellis, 1972; Hutt, 1966; Johnson, 1935; Wade & Ellis, 1971). Periodically adding new apparatus to a playspace serves to attract the attention and interest of children who use the playspace. Playspaces which have more to do in them, i.e., which have more "functional complexity," sustain greater amounts of motor activity. When children are exposed to relatively noncomplex play environments that do not change over time, the amount of motor activity evidenced in the play environment decreases, while the amount of social activity increases (Scholtz & Ellis, 1975a, 1975b; Weilbacher, 1980). Such increases in social activity are not necessarily desirable since fighting and other undesirable social behaviors may often occur. Decreases in motor activity are definitely undesirable since they reflect reduced opportunity for learning complex motor skills.

The implications of these research findings are clear. If we intend to sustain high levels of motor activites in our playspaces, and thus encourage learning, our equipment must be abundant, utilitarian, mobile, and accessible. Whenever possible, apparatus should be stored on the playspace itself, at levels which make it accessible to children and which facilitate equipment return. Also, when feasible, equipment should be selected because of its multi-use potential. Targets and projectiles should be usable in a wide variety of situations. Equipment for climbing should be lightweight and mobile, rather than permanently embedded in the ground.

Conclusion

The design, construction, evaluation, and evolution of children's playspaces is the responsibility of parents, preschool and elementary school educators, physical educators, school administrators, toy manufacturers, and landscape architects. This paper is directed to them in the hope that they will provide play environments which demonstrate increasingly greater sensitivity to the motor development and learning of the children who use them.

MOTOR PERFORMANCE AND ANTHROPOMETRIC SCREENING: MEASUREMENTS FOR PRESCHOOL AGE CHILDREN

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Virtually no standardized tests or quantitative norms for motor skill performance exist for preschool-age children. The need for such tests and performance standards is well substantiated by the fact that during these early years changes in development are so great that they are never again equalled by growth and developmental processes in any other three-year period of development (Frostig, 1966; Gesell, 1940; Piaget, 1973; Williams, 1968). The great range in performance of preschool children and the lack of appropriate tests and norms makes it difficult for the practitioner who works with young children to know if a child is above or below average in motor skill development. Until practitioners can appropriately assess and screen each child's motor skill performance, they cannot adequately design and implement programs and learning experiences to optimize the motor skill development of young children.

Concern for this problem was the impetus for the development of a Preschool Test Battery (PTB) to evaluate the motor skill development and the physical growth of children 3, 4, 5, and 6 years old and to provide preliminary standards which could be used to screen children in this age range. The motor performance portion of the test battery was designed with the help of practitioners who work regularly with preschool-age children. An attempt was made to include fundamental motor skill patterns that emerge during the preschool years, and to design test items that would be both motorically feasible and motivationally challenging for children as young as 3 years and as old as 6 years.

The equipment required for the test items was designed with economy and accessibility in mind. Although the Preschool Test Battery was initially administered by a number of trained examiners, the procedures were designed in such a way that all test items could be administered by one or two individuals in a relatively short period of time.

The remainder of this article briefly describes the test battery and its development. Preliminary standards for children aged 3 through 6 are presented. Attention is given to how the test scores can be interpreted and used to identify children who need specialized developmental experiences. While this material is written primarily for those who work with preschool children, those who teach older children may also

glean useful ideas and guidelines.

Development of the Test Battery

A preliminary survey of testing and motor development literature revealed that most tests for preschoolers focus, in large part, on fine motor control (Schaumburg, 1973; Portage Project, 1976) or on the superficial or subjective assessment of gross motor abilities, e.g., a child's ability in the long jump was measured by merely asking the child to jump over the 8 1/2 by 11 inch score sheet (Denver Developmental Screening Test as reported in Frankenburg, Dodds, and Fandel, 1970). While these tests do not adequately screen gross motor performance, there are test batteries proposed by Rarick (1976) and Williams (1974) which do, although both of these test batteries were designed for children 6 years of age and older. Consequently, many of their test items are inappropriate for the younger preschool-age child. Both of these tests, however, are credited with giving the initial direction to the development of the PTB described here.

When the PTB was originally developed, it contained subtests designed to assess basic sport skills (using performance tests and cinematographic analyses), fine and perceptual motor skills, self-concept attributes and values, physical fitness parameters, and anthropometric measurements. Initial pilot testing indicated that these subtest categories were too broad and encompassed far too many parameters for a single test battery. The final test battery was narrowed to include only motor performance test items and measures of physical size and body composition. In addition, testing practices and procedures were examined during extensive pilot testing until the investigators were satisfied that each test item, and its administrative procedures, was appropriate for children across all four age levels.

Description of the Test Battery

The final test battery was comprised of seven motor performance items and 23 anthropometric measurements. The entire battery was administered to each child, at eight testing stations, in 45 minutes. Using a carefully planned schedule it was possible, after the first testing station in which the anthropometric measurements were taken, for each child to rotate to a different station every five minutes. In order to determine the consistency of day-to-day performance on each of the test items, all of the items were administered on two different days. The two days of testing were frequently, but not always, consecutive. The two testing sessions were never separated by more than ten days. For convenience and clarification, a brief description follows of the motor performance tests and anthropometric measurements. The administration and scoring procedures, as well as a more detailed description, can be found in the Appendix for the

motor performance tests; the anthropometric measures are in Behnke and Wilmore (1974).

Motor Performance Tests

Balance. The test entailed seven trials of balancing on one foot for as long as possible. The best amd poorest performances were deleted, making the score the mean of five trials.

Scramble. The test measured how fast a child could move from a supine position to the vertical, run a short distance (10 ft.), pick up a fleece ball and return to a horizontal position. The score was the mean of four trials.

Catching. The test measured the ability to catch an aerial, underhand thrown 8 1/2-in. playground ball. The catching score was based on the quality of the catch (0-3 point scale) and was the mean of the ten test trials.

Speed Run. The test measured how fast the child could run a distance of 40 ft., given a running start, with the score being the mean of the best two out of three trials.

Standing Long Jump. The test measured how far the child could jump horizontally, using a two-foot takeoff and landing. The score was the mean of the best four trials from the two practice and three test trials.

Tennis Ball Throw for Distance. The test measured how far (aerially) the child could throw a tennis ball using any throwing pattern, providing only one step was taken and the restraining line was not crossed. The best and poorest throws were deleted, making the score the mean of five out of seven throws.

Softball Throw for Distance. Identical to the tennis ball throw except that a softball was used and only the 5- and 6-year old boys and girls were tested.

Anthropometric Measurements

In addition to height, weight, and leg length, the anthropometric measurements included seven diameter measurements, eight circumference measurements, and five skinfold measurements. The specific anthropometric measurements are listed in Table 3. (All Tables are in Appendix II.) All anthropometric measurements were taken by trained student assistants, using standardized methods of measurement as described in Behnke and Wilmore (1974). The diameter measurements were taken with a Siber anthropometer, the circumference measurements were taken with a standard anthropometric tape, and the skinfold measurements were taken with Harpenden skinfold calipers.

Each anthropometric site was measured once on the first day and once on the second day of testing. If there was a discrepancy on the second day greater than 1% of the initial value for diameters and circumferences, and 1.0 mm for skinfolds, a third measurement was taken immediately. The two measurements, or the closest two of three measurements, were averaged and these values were used in all statistical analyses

involving the anthropometric measurements.

Subjects

The subjects consisted of volunteers from (1) a random sample of children from Tucson, Arizona, and, (2) a group of children who were solicited from 44 preschools in Tucson, Arizona. The PTB was administered to 269 Caucasian boys and girls, ages 3, 4, 5, and 6, on each of two separate days. For each of the tests, the number of children in the eight age/sex groups differed because of: (1) the varied responses of volunteer subjects and (2) the willingness of the children to participate in different test items.

Analysis of the Data

The PTB scores were analyzed to determine the consistency (reliability) of performance over days and the advisability of recommending that the test item scores be based on a single day of testing rather than on the average of two separate days of testing. Also, in the interest of refining the test battery, the relationship between performance scores on the two throwing items was examined to determine whether or not both of these items should be retained in the battery. Lastly, the analysis entailed the calculation of descriptive statistics for central tendency and variability to represent the motor performance abilities and physical characteristics for each of the eight separate age/sex groups.

Performance Reliability Over Days

Motor Performance Items. In order to assess the reliability of the performance items the average scores, calculated in accordance with the testing procedures, for each of two days of testing were statistically analyzed for each of the eight age/sex groups. The relationship was determined using the Pearson-Product Moment correlation technique (Table 1, line a). A t-test was employed to determine whether there was a significant difference between the average performance of each item for each group on Day 1 and Day 2 (Table 1, line b).

Of the 52 correlations presented in Table 1, 42 (81%) were above .60, while 28 (54%) were above .80. The highest correlations occurred on the Standing Long Jump, Tennis Ball Throw for Distance, and Softball Throw for Distance. The t-test for the throwing items revealed significant differences at the .05 level in two instances, and at or beyond the .01 level in four of the twelve comparisons. In all of these instances, performance was better on Day 1 than on Day 2.

The lowest relationship between performance over two testing sessions occurred on the Catching Test. These low correlations may partially reflect the rather restricted scoring range (0 to 3) that was used in judging each trial. The

only significant t-ratio for this task was in the case of the 3-year-old girls, who were significantly better on Day 2.

For the remaining test items (Sramble, Speed Run, and Balance) correlations between performance over two testing sessions were moderate to high, with occasional correlations below .60 for certain age/sex groups. Significant differences were noted for 3-year-old boys on the Scramble and Speed Run Tests, and for 5- and 6-year old boys on the Scramble Test. In the three cases performance was better on Day 1.

In general, it was evident that the motor performance test scores for preschool boys and girls exhibited fairly high reliability and, where significant differences did occur between testing sessions, the performance was better on Day 1 than on Day 2 in 10 of the 11 instances. Therefore, for practical reasons, such as expense and time, it would seem advisable to recommend that the motor performance test item scores be based on a single day of testing rather than on the average of two days of testing.

Anthropometric Measurements. These measurements were not analyzed beyond the analysis which took place at the time of testing. The protocol involved obtaining a third measurement if the discrepancy between the first two measurements exceeded a stated value. Although the first two measurements for this study were obtained on the first and second days of testing, it is recommended that the same protocol can be carried out on a single day of testing. That is, if the discrepancy between two successive, independent, repetitions of each anthropometric measurement exceeds the stated value, a third measurement should be taken immediately and the closest two of the three measurements averaged.

Refinement of the Test Battery

In order to provide a link between throwing performance scores achieved in this test battery and data reported in the literature on the softball throw for distance by children 6 years and older, both a Tennis Ball Throw for Distance and the Softball Throw for Distance was administered to 5- and 6-year-old boys and girls. The observed correlation for all 5- and 6-year olds was .92. Since the 3- and 4-year-old children were unable to grasp the softball comfortably, and since the scores for the 5- and 6-year-olds were highly related it is recommended that the Softball Thrown for Distance be eliminated from the PTB.

Descriptive Statistics

The average scores for each child on the motor performance test battery (Day 1 only) and on the anthropometric measurements were used as the basis for calculating measures of central tendency and variability for each age/sex group. The

nature of the score distribution was an important factor in the choice of statistic to be used in describing the groups. The distributions for the motor performance items tended to be negatively skewed for some items (Catching, Scramble, and Speed and Run Tests) and positively skewed for others (Softball Throw and Balance Tests). A mixture of skewed and symmetric distributions was observed for the Standing Long Jump and the Tennis Ball Throw Tests. In order to describe the variability of the subjects, the raw scores at the 10th, 50th, and 90th percentiles were selected. It was reasoned that these percentiles would serve to identify extremely deficient or proficient preschoolers. The descriptive data for the motor performance items is presented in Table 2.

In contrast to the motor performance items the distributions of the 23 anthropometric measurements tended to be symmetric. Therefore the mean (X) and standard deviation (SD) were selected as the most appropriate statistics. These are presented in Table 3. To facilitate use of these measures, the raw scores at two standard deviations above and below the mean are also presented.

Interpretation of Test Scores

In accordance with the objective that these tests be used as a screening device to identify children who are extremely advanced or deficient in more than one of the motor performance or anthropometric measurements, score limits are provided. These will permit the user to determine whether a child is extemely deficient or proficient in a particular area. The test user should be cautioned, however, on two points regarding the interpretation of a single child's score in reference to the test results presented:

1) The reference groups that served as a basis for these test statistics consisted of Caucasian volunteers in numbers ranging from 21 to 45 for each of the eight age/sex groups. The extent to which non-Caucasian children perform similarly to these reference groups is unknown at present. Also, the degree to which these relatively small age/sex group samples reflect the performance of the larger population of children is believed to be adequate, but further data collection is necessary.

2) The value of this screening device is primarily to identify children who deviate significantly from the typical performance of the children in the reference groups. Furthermore, greater attention should be paid to the profile or general trend of a child's scores rather than to a single score on one test item. For example, concern should be greater for a child whose scores fall

below the lower score limit for the majority of items on either the motor performance or the anthropometric portion of the test battery, than for a child whose performance is seriously deficient on only a single item.

Motor Performance Items. The 10th and 90th percentile scores were selected to demark the extreme regions of the score distribution for each of the motor performance items. A child who exhibits a pattern or trend of performance above the 90th percentile (indicating that the child is better than 90% of those in the age/sex group) or below the 10th percentile (indicating that the child's performance is poorer than 90% of the reference group) may be deserving of special attention. The form of special attention given to children whose scores were markedly deficient on several items might be recommended to consist of extra, individualized instruction and practice, both at school and at home, on those skills in which performance was poor. Although there are few motor skill books aimed at the preschool child, the practitioner may wish to consult Arnheim and Pestolesi (1978), Flichum (1975), McCleaghan and Gallahue (1978) and Wickstrom (1977) for suggestions regarding activities which could be prescribed. A child whose scores ranked at or above the 90th percentile on some, but not all, items might be encouraged to focus participation and practice on those other skills that were not yet performed at a superior level. This latter recommendation reflects a philosophy that stresses the development of a well-rounded repertoire of motor abilities in young children rather than a specialization in only a few skills.

An illustration of the interpretation of motor performance scores of individual children may be helpful. The scores of four children are presented in Table 4. Both the 3-year-old girl and the 6-year-old boy had raw scores at or below the 10th percentile for all items except the Catching and Balancing Tests. Since their performance of running, jumping, and throwing skills ranked below that of 90% of the reference group subjects, special attention should be given to improving these abilities. Although the 4-year-old boy and the 5-year-old girl performed exceptionally well on one or two items, their prescription for instruction and practice of motor skills should probably be to continue an active and varied program of activities.

Anthropometric Measurements. The raw scores at two standard deviations above and below the mean were selected to demark the extreme regions of the score distribution for each of the anthropometric measurements. When scores are normally distributed, approximately 95% of the scores fall between -2 SD and +2 SD, while 5% fall outside this range, 2.5% at the upper extreme and 2.5% at the lower extreme. A child whose raw score on any item falls below the score associated with -2 SD or above that associated with +2 SD is clearly differentiated from

the majority of students in the reference group. Once again, it should be stressed that a single deviant measurement should not be cause for concern. Instead, the pattern or trend of a child's measurements should be examined to learn whether that child's size is similar to or quite different from other children of the same age.

If several of the anthropometric measurements of a 4-year-old boy, for example, exceeded the +2 SD value, this may merely indicate that his growth rate has surpassed others of his age and sex. However, if the excessively high score occurred primarily among the skinfold measurements and possibly among the circumference measurements, there might be cause to have the child checked by a physician to see if he is obese, i.e., has excessive body fat. A child whose profile of anthropometric measurements included several items below the -2 SD score also might be singled out for closer attention because this might imply an inadequate nutritional status.

Summary

The preceding data clearly indicate that the PTB can be used to screen selected motor performance capabilities and anthropometric measurements of children 3 to 6 years old. Further, it may be concluded that the Preschool Test Battery can be administered in a single testing session. This test administration procedure, substantiated by both the correlation and t-test analyses, eliminates the necessity of children returning for a second day of testing. Lastly, it is evident that the Preschool Test Battery can be shortened by eliminating the Softball Throw for Distance since it correlates highly with the Tennis Ball Throw for Distance.

APPENDIX I

Motor Performance Tests in the Preschool Test Battery

The administration of each test item in the PTB was carefully controlled in order to eliminate contaminants in the data collection procedures. All test items were administered by trained research technicians (RT). Except for the throwing test, each testing station was located in a separate room or partitioned area, thus providing an environment where noise and extraneous activity were relatively well controlled. The testing stations were arranged in such a way that the child entered the first station and proceeded sequentially to each of the following stations. The test items were administered to each child individually. Throughout the testing session the child was accompanied to the testing station by a research assistant (RA) who was able to establish confidence and rapport with the child. During their initial meeting the RA helped the child remove his/her shoes since all tests, except throwing, were performed in bare feet.

The RT assigned to each testing station was responsible for administering the test to each of the children. The RAs served as recorders and, in some cases, helped complete quantitative measurements. The administrative procedures for each of the motor performance items are presented below.

CATCHING

The purpose of this test was to measure the child's ability to catch an aerial ball. The technician tossed an 8 1/2 inch playground ball underhand through a two-foot diameter hula hoop placed halfway between the child and the technician. The hula hoop was positioned so that the distance between the bottom of the hoop and the floor (D2), and its distance from the technician (D1) and from the child (D3) was equal to the child's height (see Figure 1a).

Equipment:
1) 8 1/2 inch playground ball
2) hula hoop, two-foot diameter
3) adjustable support for hula hoop
4) three tape measures; one attached to support standard, two attached to floor to be used in placement of restraining lines
5) masking tape
6) test instructions and score sheet

Administration:
1) adjust height of hula hoop
2) determine distance of restraining lines and mark with masking tape
3) administer 2 demonstration trials, 2 practice trials, 10 test trials
4) repeat trial if:
   a) child not attending when ball thrown
   b) ball poorly tossed

Scoring
1) awarding points
   a) 3 POINTS - "Two-Hand Catch" touched only by the hands; immediate control of ball; once ball controlled in hands it could be brought toward the chest.
   b) 2 POINTS - "Basket Catch" any catch other than a two-handed catch.
   c) 1 POINT - "Attempted Catch - Ball Not Caught" ball touched by hands but not caught.
   d) 0 POINTS - "Moved Away From Ball - Attempted to Avoid Ball - No Catch no attempt made to catch ball; no hand contact.
   2) total catching score equaled the mean of the ten test trials.

SCRAMBLE

The purpose of this test was to measure how fast the child could move from the supine to the vertical, run a short distance, pick up a fleece ball, and return to a horizontal position. The technician instructed the child to assume a back-lying (supine) position with arms and legs extended toward the fleece ball. On the signal "go" the child moved as quickly as possible from the starting position to run to pick up the ball and return to a horizontal position. At the start and end of each trial the horizontal position was assumed on a gymnastics mat taped to the floor ten feet from the fleece ball. Masking tape was used to mark a five-foot line halfway between the mat and the ball (see Figure 1b).

Equipment:
1) gymnastic mat
2) fleece ball
3) 1/10 second stopwatch
4) mat tape and masking tape
5) test instructions and score sheet

Administration:
1) demonstration trial
2) practice trial
3) four consecutive test trials
4) repeat trial if
   a) child was distracted or failed to move continuously during trial
   b) child dropped the ball during the run
   c) technician failed to time the trial

Scoring:
1) start stopwatch at go
2) stop stopwatch when child crosses 5 foot line after picking up fleece ball

3) total score equaled the mean of the four test trials.

SPEED RUN

The purpose of this test was to measure how fast the child could run a distance of 40 feet. Since the test was designed to eliminate acceleration and deceleration effects, only the middle 40 feet of a 64-foot running distance was timed. The technician instructed the child to "run as fast as possible", at the signal "go", toward the assistant, who was standing at the finish line wearing a red cape. The assistant was responsible for encouraging the child to run all the way to the finish and also served as one of the timers. The other timer was positioned at the end of the 40-foot running distance.

The test was administered on a gymnasium floor. Tape lines were used to identify the starting line, the finish line, and the two intermediate lines. Benches were used to define the six-foot wide running course. (The benches were necessary to help the children run in a straight line instead of veering off to one side.) Flags were used to mark the finish line (see Figure 1c).

Equipment:
1) two 1/100 second stopwatches
2) yellow tape for floor markings
3) flags for the finish line
4) red cape
5) benches
6) test instructions and score sheets.

Administration:
1) demonstration trial
2) three consecutive test trials (with one minute rests)
   a) start trial with "ready-set-go"
   b) move to first (12') line
   c) give hand signal for timers to start watches as child crosses first line
   d) stop watches as child crossed 52' line.
3) repeat trial if
   a) child stepped across starting line prior to "go" signal
   b) child fell during trial
   c) child failed to run a straight course from start to finish
   d) child lost interest and slowed down or stopped during trial
   e) assistant or timer failed to time trial
   f) discrepancy of greater than 2/10 seconds between times.

Scoring:
1) average the two times for each trial (if differ by more than 2/10 secs. use the time most similar to the child's other trials)
2) total score equalled the average of best two test trials

STANDING LONG JUMP

The purpose of this test was to measure how far the child could jump horizontally, using a two-foot takeoff and landing. The child was directed to place the feet about shoulder width apart, bend both knees, move the arms back and swing them forward when jumping. The child was encouraged to jump "as far as possible". To insure accuracy in measuring the distance that the child jumped, a tape measure was taped to the floor, perpendicular to the restraining line. Red, yellow, blue and green tape was placed on the floor parallel to the restraining line to enable accurate determination of where the child's feet landed. In order to assist the child in initial placement of the feet the technician placed a yardstick on its edge at the restraining line. The child was instructed to place the toes of both feet against the stick (see Figure 1d).

Equipment:
1) tape measure
2) masking tape and colored vinyl tape
3) yardstick
4) test instructions and score sheets

Administration:
1) demonstration
2) three test trials
3) repeat trial if
   a) child fell backward on landing
   b) child failed to use a two-foot takeoff
   c) child failed to land on both feet simultaneously
   d) child moved across restraining line prior to the jump
   e) technician unable to measure the distance the child jumped

Scoring
1) measure distance from heel of foot nearest takeoff line to nearest 1/4"
2) round distances jumped during two practice and three test trials to nearest inch
3) total score equaled the mean of best four trials from eligible practice and test trials.

BALANCE

The purpose of this test was to measure how long the child could balance while standing on one foot. The child was instructed to stand on two adjacent balancing blocks (two inches apart and four inches off the floor). Once stationary the child was instructed to balance on one foot for as long as possible (see Figure 1e). The

child was allowed to use either foot, the assistant merely indicated the support foot for each trial on the score sheet.

Equipment:
1) two balancing blocks
2) 1/100 sec. stopwatch
3) test instructions and score sheets

Administration
1) demonstration trial
2) practice trial
3) six consecutive test trials
4) brief stationary period between each trial:
   a) both feet positioned on blocks
   b) technician holding child's feet stationary
5) repeat trial if
   a) technician unable to time trial

Scoring:
1) start watch when child raises non-support foot
2) stop watch when non-support foot, or any other part of body, touches block or floor
3) record time-in-balance to nearest 1/100 sec.
4) indicate preferred support foot
5) eliminate highest and lowest of seven (practice plus test) trials
6) total score equaled the mean of the five remaining balance times

TENNIS BALL (SOFTBALL) THROW FOR DISTANCE

Since the procedures for the softball and tennis ball throws for distance tests are the same (except for the type of ball used) only the tennis ball throw for distance will be described. The purpose of this test was to measure how far the child could throw a tennis ball. The child was instructed to get a tennis ball from a container located three feet behind the restraining line and then to stand behind and near the restraining line and throw the ball as far as possible within the designated throwing area and in the direction of an obstacle positioned approximately ten feet beyond the child's estimated longest throw (see Figure 1f). The child was allowed to take one step forward during the throw but was not permitted to step over the restraining line. The overarm throwing pattern was considered preferable but was not required. The type of throwing pattern and the hand used was indicated on the score sheet.

A 100-foot tape measure was secured at the restraining line and extended through the middle of the designated throwing area. The seven balls were intentionally placed behind the restraining line so that the child had to move to select a ball. This required the child to reposition the feet before each trial.

Equipment:
1) a container with seven tennis balls
2) a 100-foot tape measure
3) obstacle (three feet high)
4) masking tape or line to mark designated throwing area
5) checkers or icepicks (numbered one to seven) to mark the distance of each throw
6) test instructions and score sheets

Administration:
1) demonstration using overarm throw
2) two practice trials
3) five test trials
4) repeat trial if:
   a) child's striding foot crossed restraining line
   b) the ball appeared to have "slipped" out of the child's hand at release
   c) child threw with two hands
   d) ball failed to land in designated area
   e) technician was unable to score throwing distance
   f) ball hit the obstacle

Scoring:
1) after each trial mark the initial landing position of the ball
2) record hand and type of throw on score sheet
3) after completion of test session measure the distance of each throw to nearest inch
4) eliminate longest and shortest of seven (practice plus test) distances
5) total score equaled the mean of the remaining five distances

Table 1

Correlations and Difference in Performance Between Day 1 and Day 2 on the Motor Performance Test Items

Test		Girls				Boys			
		3	4	5	6	3	4	5	6
Catching	r[a]	.52	.37	.32	.77	.70	.63	.54	.59
	p[b]	.02	.93	.82	.37	.82	.21	.77	.27
Scramble	r	.85	.76	.49	.76	.62	.58	.49	.93
	p	.09	.10	.69	.09	.02	.72	.05	.04
Speed Run	r	.90	.92	.74	.83	.58	.78	.83	.75
	p	.20	.62	.75	.15	.03	.11	.30	.81
Standing Long Jump	r	.87	.81	.86	.92	.76	.91	.87	.86
	p	.05	.08	.79	.65	.73	.38	.65	.29
Tennis Ball Throw for Distance	r	.73	.82	.92	.84	.88	.90	.91	.88
	p	.28	.05	.07	.33	.05	.00	.00	.30
Softball Throw for Distance	r	---	---	.87	.83	---	---	.95	.84
	p	---	---	.01	.96	---	---	.00	.52
Balance	r	.70	.94	.82	.53	.74	.84	.72	.94
	p	.40	.84	.10	.73	.10	.29	.20	.06

[a]Coefficient Represents Correlation Coefficient

[b]Coefficient Represents t-test 2-tail Probability Coefficient

Table 2

Descriptive Statistics for Motor Performance

Test Items: Day 1

Tests		Girls				Boys			
		3	4	5	6	3	4	5	6
Catching (0-3 scale)	N =	20	41	29	23	36	42	42	32
90%		2.00	2.40	3.00	3.00	2.10	2.60	2.80	3.00
50%		1.60	1.90	2.40	2.60	1.70	1.80	2.40	2.70
10%		.90	1.30	1.70	2.10	1.40	1.60	1.80	1.50
Scramble (sec)	N =	27	43	38	23	33	42	42	22
90%		4.65	4.10	3.65	3.65	4.30	3.95	3.48	3.42
50%		5.28	4.68	4.10	4.00	5.15	4.85	3.98	3.85
10%		6.42	5.50	4.63	4.80	6.36	5.55	4.47	4.60
Speed Run (sec)	N =	29	45	20	23	35	42	42	22
90%		3.25	2.83	3.48	2.50	3.01	2.77	2.38	2.36
50%		3.05	3.31	2.88	2.72	3.45	3.19	2.64	2.62
10%		4.93	4.21	3.38	3.07	4.11	3.78	3.06	2.99
Standing Long Jump (in)	N =	30	45	29	23	34	42	42	22
90%		37.75	35.00	42.75	47.50	32.25	36.75	49.50	54.75
50%		29.50	26.25	35.25	40.25	22.00	27.50	41.00	46.25
10%		20.25	16.00	24.25	30.50	13.75	19.75	30.25	38.75
Tennis Ball Throw (ft)	N =	30	45	29	23	35	42	42	22
90%		13.60	20.07	26.69	30.30	25.01	29.98	31.39	34.57
50%		8.77	12.34	18.43	22.47	18.18	21.98	31.21	36.73
10%		5.25	8.59	10.27	16.80	8.11	8.61	17.61	26.00
Softball Throw (ft)	N =	---	---	39	24	---	---	42	21
90%		---	---	19.76	24.47	---	---	40.35	44.58
50%		---	---	13.95	19.60	---	---	23.17	28.12
10%		---	---	8.09	11.45	---	---	12.16	16.82
Balance (sec)	N =	30	45	23	22	35	42	42	22
90%		7.48	12.82	47.37	156.23	4.27	11.52	30.86	46.46
50%		3.37	5.11	12.41	26.99	2.21	3.74	10.99	12.21
10%		1.29	1.70	3.33	4.21	1.23	1.66	3.61	5.69

Table 3

Descriptive Statistics for Anthropometric Measurements

Measurements	Girls				Boys			
	3	4	5	6	3	4	5	6
STATURE (N)	30	45	29	23	36	42	42	22
Height (in)								
$\bar{X}$ (SD)	38.3 (1.6)	41.0 (2.2)	43.2 (3.0)	46.5 (2.5)	39.1 (2.5)	41.2 (1.9)	44.3 (1.9)	46.4 (2.4)
$\bar{X}$ +2 SD	41.5	45.4	49.2	51.5	44.1	45.0	48.1	51.2
$\bar{X}$ -2 SD	35.1	36.6	37.2	4 .5	34.1	37.4	40.5	41.6
Weight (lb)								
$\bar{X}$ (SD)	33.3 (4.2)	36.8 (4.6)	42.2 (6.0)	47.5 (6.5)	35.6 (5.1)	37.0 (4.3)	43.6 (5.2)	47.9 (7.9)
$\bar{X}$ +2 SD	41.7	46.0	54.2	60.5	45.8	46.4	54.0	63.7
$\bar{X}$ -2 SD	24.9	27.6	30.2	34.5	25.4	29.2	33.2	32.1
Leg Length (cm)								
$\bar{X}$ (SD)	43.7 (2.2)	47.5 (2.7)	52.2 (2.9)	57.5 (4.1)	44.5 (2.9)	47.6 (2.7)	52.3 (2.9)	55.9 (4.0)
$\bar{X}$ +2 SD	48.1	52.9	58.0	65.7	50.3	53.0	58.1	63.9
$\bar{X}$ -2 SD	39.3	42.1	46.4	49.3	38.7	42.2	46.5	47.9
DIAMETER (N)	30	45	29	23	36	42	42	22
Biacromial (cm)								
$\bar{X}$ (SD)	22.1 (1.1)	23.1 (1.1)	24.5 (1.1)	25.9 (1.3)	22.5 (1.3)	23.3 (1.2)	24.9 (1.3)	25.6 (1.6)
$\bar{X}$ +2 SD	24.3	25.3	26.7	30.5	25.1	25.7	27.5	28.8
$\bar{X}$ -2 SD	19.9	20.9	22.3	23.3	19.9	20.9	22.3	22.4

Measurements	Girls				Boys			
	3	4	5	6	3	4	5	6
DIAMETER (N)	30	45	29	23	36	42	42	22
Chest (cm)								
$\bar{X}$ (SD)	16.5 (.7)	17.0 (.9)	17.4 (.9)	18.6 (1.1)	17.2 (1.0)	17.3 (.7)	18.1 (.9)	18.6 (1.1)
$\bar{X}$ +2 SD	17.9	18.8	19.2	20.8	19.2	18.7	19.9	20.8
$\bar{X}$ -2 SD	15.1	15.2	15.6	16.4	15.2	15.9	16.3	16.4
Bi-iliac (cm)								
$\bar{X}$ (SD)	16.1 (.8)	17.1 (.9)	17.9 (1.0)	18.7 (1.0)	16.6 (.9)	17.3 (1.0)	18.2 (.8)	18.8 (1.3)
$\bar{X}$ +2 SD	17.9	18.9	19.9	20.7	18.4	19.3	19.8	21.4
$\bar{X}$ -2 SD	14.7	15.3	15.9	16.7	14.8	15.3	16.6	16.2
Bitrochanteric (cm)								
$\bar{X}$ (SD)	17.3 (.8)	18.2 (.8)	19.1 (1.1)	20.0 (1.2)	17.8 (1.0)	18.1 (1.1)	19.3 (.9)	20.1 (1.4)
$\bar{X}$ +2 SD	18.9	19.8	21.3	22.4	19.8	20.3	21.1	22.9
$\bar{X}$ -2 SD	15.7	16.6	16.9	17.6	15.8	15.9	17.5	17.3
Ankle (cm)								
$\bar{X}$ (SD)	4.6 (.3)	4.7 (.3)	4.9 (.3)	5.1 (.3)	4.8 (.3)	4.9 (.3)	5.2 (.3)	5.3 (.3)
$\bar{X}$ +2 SD	5.2	5.3	5.5	5.7	5.4	5.5	5.8	5.9
$\bar{X}$ -2 SD	4.0	4.1	4.3	4.5	4.2	4.3	4.6	4.7
Elbow (cm)								
$\bar{X}$ (SD)	4.0 (.2)	4.1 (.3)	4.4 (.3)	4.5 (.3)	4.2 (.3)	4.3 (.3)	4.5 (.3)	4.6 (.4)
$\bar{X}$ +2 SD	4.4	4.7	5.0	5.1	4.8	4.9	5.1	5.4
$\bar{X}$ -2 SD	3.6	3.5	3.8	3.9	3.6	3.7	3.9	3.8

Measurements	Girls				Boys			
	3	4	5	6	3	4	5	6
DIAMETER (N)	30	45	29	23	36	42	42	22
Wrist (cm)								
$\bar{X}$ (SD)	3.4 (.2)	3.5 (.2)	3.7 (.2)	3.8 (.2)	3.5 (.2)	3.6 (.2)	3.8 (.2)	3.9 (.2)
$\bar{X}$ +2 SD	3.8	3.9	4.1	4.2	3.9	4.0	4.2	4.3
$\bar{X}$ -2 SD	3.0	3.1	3.3	3.4	3.1	3.2	3.4	3.5
CIRCUMFERENCE (N)	30	45	29	23	36	42	42	22
Shoulders (cm)								
$\bar{X}$ (SD)	63.5 (2.3)	66.1 (3.3)	68.0 (3.7)	71.6 (3.8)	65.3 (3.3)	66.4 (2.8)	69.7* (3.1)	72.2 (4.4)
$\bar{X}$ +2 SD	68.1	72.7	75.4	79.2	71.9	72.0	75.9	81.0
$\bar{X}$ -2 SD	58.9	59.5	60.6	64.0	58.7	60.8	63.5	63.4
Chest (cm)								
$\bar{X}$ (SD)	52.1 (2.4)	53.7 (2.7)	55.1 (2.7)	58.4 (3.6)	53.4 (2.7)	54.5 (2.4)	57.1 (2.5)	58.9 (3.8)
$\bar{X}$ +2 SD	56.9	59.1	60.5	65.6	58.8	59.3	62.1	66.5
$\bar{X}$ -2 SD	47.3	48.3	49.7	51.2	48.0	49.7	52.1	51.3
Abdominal (cm)								
$\bar{X}$ (SD)	49.4 (2.5)	50.7 (3.3)	51.4 (3.7)	52.8 (3.4)	50.5 (3.7)	51.0 (2.6)	52.5 (3.5)	53.5 (4.5)
$\bar{X}$ +2 SD	54.4	57.3	58.8	59.6	57.9	56.2	59.5	62.5
$\bar{X}$ -2 SD	44.4	44.1	44.0	46.0	43.1	45.8	45.5	44.5
Hips (cm)								
$\bar{X}$ (SD)	53.0 (2.6)	55.4 (3.2)	57.7 (3.9)	60.6 (4.3)	54.2 (3.5)	55.3 (2.9)	58.5 (3.5)	60.2 (4.8)
$\bar{X}$ +2 SD	58.2	61.8	65.5	69.2	61.2	61.1	65.5	69.8
$\bar{X}$ -2 SD	47.8	49.0	49.9	52.0	47.2	49.5	51.5	50.6

*N = 41 for 5-year-old boys on shoulder circumference

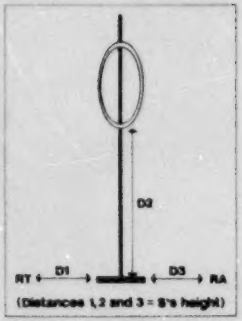
Measurements	Girls				Boys			
	3	4	5	6	3	4	5	6
CIRCUMFERENCE (N)	30	45	29	23	36	42	42	22
Thigh (cm)								
$\bar{X}$ (SD)	29.6 (2.0)	31.1 (2.4)	32.7 (3.4)	34.5 (3.1)	29.8 (2.5)	30.3 (2.3)	32.6 (4.5)	33.1 (4.1)
$\bar{X}$ +2 SD	33.6	35.9	39.5	40.7	34.8	34.9	41.6	41.3
$\bar{X}$ -2 SD	25.6	26.3	25.9	28.3	24.8	25.7	23.6	24.9
Calf (cm)								
$\bar{X}$ (SD)	21.0 (1.0)	21.7 (2.2)	22.4 (1.8)	23.2 (1.5)	21.2 (1.4)	21.6 (1.3)	23.1 (1.9)	23.1 (1.8)
$\bar{X}$ +2 SD	23.0	26.1	26.0	26.2	24.0	24.2	26.9	26.7
$\bar{X}$ -2 SD	19.0	17.3	18.8	20.2	18.4	19.0	19.3	19.5
Biceps Flexed (cm)								
$\bar{X}$ (SD)	17.0 (.9)	17.5 (1.3)	17.9 (1.5)	18.6 (1.4)	17.2 (1.4)	17.3 (1.1)	18.1 (1.4)	18.5 (1.7)
$\bar{X}$ +2 SD	18.8	19.9	20.9	21.4	20.0	19.5	20.9	21.9
$\bar{X}$ -2 SD	15.2	14.7	14.9	15.8	14.4	15.1	15.3	15.1
Forearm (cm)								
$\bar{X}$ (SD)	16.0 (.7)	16.3 (1.0)	16.8 (1.3)	17.3 (1.0)	16.4 (.9)	16.6 (.9)	17.2 (1.0)	17.7 (1.0)
$\bar{X}$ +2 SD	17.4	18.3	19.4	19.3	18.2	18.4	19.2	19.7
$\bar{X}$ -2 SD	14.6	14.3	14.2	15.3	14.6	14.8	15.2	15.7
SKINFOLD (N)	29	44	29	23	35	42	42	22
Scapula (mm)								
$\bar{X}$ (SD)	6.6 (1.3)	6.6 (1.8)	6.2 (2.0)	6.7 (1.8)	6.4 (1.2)	6.0 (1.2)	5.7 (2.1)	6.6 (2.1)
$\bar{X}$ +2 SD	9.2	10.2	10.2	10.3	8.8	8.4	9.9	10.2
$\bar{X}$ -2 SD	4.0	3.0	2.2	3.1	4.0	3.6	1.5	1.8

Measurements	Girls				Boys			
	3	4	5	6	3	4	5	6
SKINFOLD (N)	28	44	29	21	35	42	42	22
Triceps (mm)								
$\bar{X}$ (SD)	10.2 (1.9)	9.8 (2.1)	9.7 (2.4)	10.3 (2.4)	10.3 (1.8)	9.6 (1.9)	9.1 (2.0)	8.9 (2.4)
$\bar{X}$ +2 SD	14.0	14.0	14.5	15.1	13.9	13.4	13.1	13.7
$\bar{X}$ -2 SD	6.4	5.6	4.9	5.5	6.7	5.8	5.1	4.1
Suprailiac (mm)								
$\bar{X}$ (SD)	7.1 (1.8)	7.4 (2.0)	7.2 (2.8)	7.8 (2.5)	7.3 (2.9)	6.8 (1.8)	6.1 (2.2)	7.0 (3.2)
$\bar{X}$ +2 SD	10.9	11.4	12.8	12.8	13.1	10.2	10.5	13.4
$\bar{X}$ -2 SD	3.7	3.4	1.6	2.8	1.5	3.0	1.7	.6
Abdominal (mm)								
$\bar{X}$ (SD)	6.6 (1.8)	6.6 (2.2)	6.9 (3.1)	7.6 (2.5)	6.9 (2.2)	6.5 (1.8)	5.8 (1.8)	6.2 (3.2)
$\bar{X}$ +2 SD	10.2	11.0	13.1	12.7	11.3	10.1	9.4	12.6
$\bar{X}$ -2 SD	3.0	2.2	.7	3.0	2.5	2.9	2.2	0
Thigh (mm)								
$\bar{X}$ (SD)	14.0 (2.4)	14.4 (3.1)	15.2 (3.6)	15.4 (3.4)	13.7 (3.2)	13.5 (3.2)	13.0 (3.3)	13.4 (4.0)
$\bar{X}$ +2 SD	18.8	20.6	22.4	22.2	20.1	19.7	19.6	21.4
$\bar{X}$ -2 SD	9.2	8.2	8.0	8.6	7.3	7.3	6.4	5.4

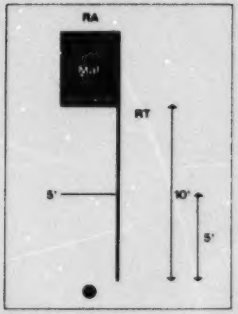
Table 4. Illustration of Interpretation of Performance Scores

	3-yr Girl	4-yr Boy	5-yr Girl	6-yr Boy
Catching	1.70	1.70	2.70	1.90
Scramble (sec)	6.60*	4.95	3.60**	5.38*
Speed Run (sec)	4.98*	3.15	2.77	2.99*
Standing Long Jump(in)	10.05*	19.95	38.25	22.25*
Tennis Ball Throw(ft)	4.80*	33.20**	24.43	18.18*
Softball Throw(ft)	---	---	16.80	14.32*
Balance (sec)	7.25	1.92	59.92**	8.11

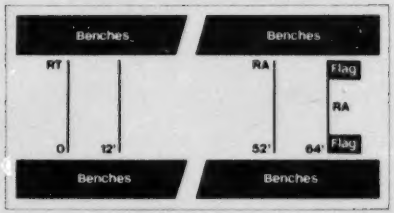
* Raw score at or below 10th percentile
** Raw score at or above 90th percentile



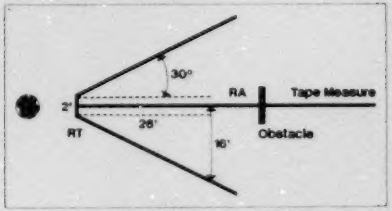
Catching



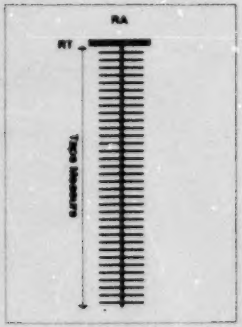
Scramble



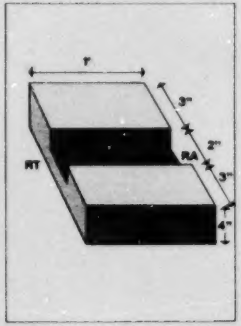
Speed Run



Tennis Ball Throw for Distance



Standing Long Jump



Balance

Figure 1. Dimensions of the Motor Performance Test Items including positions of the research technician (RT) and research assistant (RA).

FROM THEORY TO PRACTICE: A SUMMARY

Bob Pangrazi
Nonda Chomokos
Debbie Massoney

The preceding articles in this monograph offer insights and research findings about young children and their motor development. This chapter focuses on key points provided in this monograph and their application in teaching. The applications are centered on the creation of a better learning environment for children.

The Physical Education Program

A broad program of activities enhances learning of motor control

The critical years for motor skill learning are from 3 to 9. Physical education program must be planned and designed to enhance the development of the mechanisms of force production and motor control. Since children differ in interests and competencies, programs must include a wide variety of activities. Many physical education programs are narrow in scope and center around specific areas such as sports, gymnastics and rhythms. A broader, more comprehensive program including different types and levels of activities is necessary to meet the wide range of interests and abilities of young children.

Activities should vary in degree of difficulty

All children, including those with learning disabilities, need the opportunity to experiment and try activities in an environment that is accepting and secure. In addition, they must experience success if they are to feel comfortable and motivated. When all students are expected to progress at the same rate and to the same level, some will fail. Variation in physical development as determined by skeletal age is a better predictor of success in most activities than height, weight, or chronological age. Thus, teachers must be aware that children in the same grade or of the same age will vary widely in their physical maturity and that this variation will affect performance in motor activities. Once again, a broad program of activity offerings will assure that each child can progress at a comfortable pace and with maximum opportunity for success. In addition, a broad program incorporating novel and diverse activities would have the potential to meet the interests of all children and would help to heighten motivation.

Arranging the Teaching Environment

Match game skills to the child's developmental status

The setting in which skill development takes place can be arranged in many ways. For example, striking activities in certain games can be modified by changing the way the ball is delivered, by using different sizes and colors of balls, and by altering the types of striking implements used. Use of appropriate alternatives will assure that each child has an optimal chance to succeed.

Further, tasks must be sequenced so that they coincide with developmental stages. Incorporation of task sheets that children can work on at various learning stations will enable children to select activities of interest and to work at a level where they can succeed. Equipment can also be modified for similar selection by the child. Teachers can provide baskets at different heights, goals of various widths, and targets at various distances to allow children to select freely according to their ability and for meaningful challenges.

The teaching environment must be arranged so that it provides feedback about the child's performance. This feedback helps children to maintain interest, to develop an accurate conception of their level of performance, and to improve their performance. The learner cannot be expected to improve performance if practice occurs without feedback. Since the teacher cannot be everywhere at once, the use of equipment which provides constant feedback can enable the child to obtain feedback when the teacher is not there. Colors might be used to signal increasing difficulty or levels of success; timing devices can offer feedback about quickness or speed; lights and buzzers can be utilized with different pieces of equipment to signal when balance is lost, when targets have been hit, or when goals have been reached.

Understanding Motor Development Processes in Children

Production of appropriate force is a major developmental factor

The child must gain control over neuromuscular processes so that the force produced is appropriate to the task at hand. Youngsters have to learn to perform movements in a controlled and efficient manner. In the early stages of learning, children cannot perform motor skills without excessive movement and inappropriate force. One of the first things children learn when exposed to motor tasks is to generate force in direct relationship to the amount needed. Economy of effort is a mark of a skilled performer.

One of the ways in which learners minimize effort is through synchronized motor unit firing. This suggests that through experience and training, changes in neurophysiological functioning occur. Practice and repetition is necessary to enhance the development of force production and motor control.

It is therefore essential for children to repeat activities over and over if skills are to be effectively learned. Both quantity and quality of movement experience is necessary for skill refinement. Repetition also appears to enhance the ability of youngsters to learn new skills efficiently. For example, older children are able to use a different and more efficient pattern of neuromuscular control to adapt or accommodate to unfamiliar situations. This more effective adaptation of the neuromuscular system to new and unfamiliar tasks may be one of the most important benefits of added experience and training in motor activities. Thus, repetition appears to enhance performance of skills in the present and learning of new skills in the future.

The optimal time for learning skills is 4 to 9 years

Teachers can expect the most dramatic gains in skill acquisition and refinement to occur at 4 to 9 years. While children in the 4 to 6 range have difficulty superimposing new skills on previously learned skills, those from 7 to 9 years appear to be quite successful in this regard. This latter time period, then, is a critical time to teach new skills. In addition, children will be capable of greater success at complex tasks than if they were taught at the earlier ages.

It is evident that the ages 4 to 9 years are critical for motor development and that physical activity is an important part of the developmental sequence. Research reinforces the point that physical education programs are necessary from the preschool years through the child's school career. This research guideline is violated in all of the school systems that offer physical education programs only in the intermediate grades. Teachers can use research information to support the inclusion of programs at all levels and to stress that inclusion is critical from kindergarten through third grade.

The learning disabled child must be offered the same opportunities as other youngsters. It is particularly important to provide an accepting and secure environment in which these youngsters can explore and experiment. It is also important that the program be challenging and success-oriented, that it provide for novelty and variety, and that it provide for feedback about performance and improvement.

Modifying Activities and Apparatus

Match activities and apparatus to the child's developmental level

Skills involving catching, kicking, and striking require rapid processing of visual information. Young and unskilled children are less capable of processing visual information and of discriminating the important features. The teacher should consider modifying and adapting activities and equipment to insure the maximum skill development.

When striking activities are involved, for example, the size of the ball has little influence on success. Any ball larger than four inches in diameter is satisfactory. On the other hand, the speed of the ball is critical. Research findings indicate that greater success in striking is achieved with slower moving balls. Children should begin their striking activities with slow moving objects such as birdies, aerial darts, and balloons. Beach balls and tethered balls are also quite useful in the early stages. The weight of balls and balloons can be increased gradually to increase their speed.

Teaching progressions which involve moving objects should begin with balls that are rolled, and then progress to aerial and bounced balls. The distance the ball travels and the number of times the ball bounces should be adapted to each child's skill level. Specifically, the distance the object is thrown, rolled, or bounced should be short at first and then gradually lengthened to perhaps twenty feet. The balls should be directed to the child's preferred side, then to the midline, and finally, to the non-preferred side as skill develops. The color of the projectiles and the surrounding walls should be considered. In the early stages, contrast should be high. The background should be a dark, solid color and the objects should be light. A yellow ball moving against a grey background is most preferable. Blue and yellow balls have been found to be associated with greater success than white or red balls, although the child's color preference may have some bearing on choice. As the child becomes more skilled, the contrast should be reduced and the background complexity increased to provide more variety and challenge.

The use of targets in conjunction with throwing activities is vital. Targets should be: located at appropriate distances from the thrower; large enough to enable children to concentrate more on velocity than on accuracy; and positioned appropriately for the type of skill, e.g. above head level for overhand throwing, and from knee to above head level for striking activities. The use of targets provides an excellent means of supplying the child with immediate feedback about the outcome of the throw.

Implements used for striking should be carefully evaluated by the teacher. The length, surface area, weight, and grip characteristics of implements influence the amount and efficiency of force production. Rackets and bats of similar weight but different lengths, as well as implements of similar lengths but differing surface areas, should be available. Implements which are shorter and lighter, and which have a larger surface area, are easier to use than those which are longer and heavier, and which have a smaller striking surface. The size of the grip is important in that it must not be too large, since this will inhibit effective force production.

The pre-school test battery described in this monograph can be used by teachers to carry out various types of action

research. It offers screening standards and comparative data for Caucasian children ages 3 through 6. Thus, the test battery provides the teacher with a means of identifying the level of motor skill development in preschool youngsters. The tests can also be used to provide performance data to evaluate different teaching procedures and/or to gauge the effectiveness of modifying activities and equipment in enhancing the learning of motor skills. Ultimately, teachers can develop screening standards for their own geographical area and use the data to diagnose individual differences and needs. The individual test items can be administered by classroom teachers in public or private school settings.

Children in Competitive Situations

Allow children to participate in a non-threatening environment

Children should be allowed to participate in sports within a non-threatening environment where they can learn fundamental motor skills at a rate that is based upon their individual abilities. The association between skeletal age, height, weight, and motor development indicates that the most biologically mature children within an age group have an advantage in sports competition. Teachers and coaches must consider that children classified according to chronological age can differ many years in biological maturity. Since it is unreasonable to assume that youngsters of different maturational levels will demonstrate comparable levels of motor skill, teachers and coaches should modify their expectations and demands accordingly.

Teachers, coaches and parents should be aware that youngsters are susceptible to certain types of sport related injury. The most common injury sites are the elbow, shoulder, knee and ankle. The epiphyses of youngsters are the most easily injured, and such injuries can cause permanent damage. Although research studies seem to report conflicting results in terms of joint injury in baseball players, one well substantiated conclusion indicates that high pressure competition and extended playing schedules increase susceptibility to joint injuries.

Another area of concern relates to the exclusion of less skilled children from sport activities. These children are thus robbed of opportunities to continue practicing the skills they lack. This increases the gap between the skilled and unskilled, and may create a situation which cannot be reversed later. Every effort should be made to allow every child to participate; such opportunities will provide the chance for "late-bloomers" to achieve their potential. It is a dubious practice to "cut" youngsters at an early age. This is especially true since it has been shown that athletes identified as outstanding in elementary school were not necessarily outstanding in later school years.

There are several alternatives for restructuring competitive situations for youngsters based on their developmental readiness. Teams might be selected to include children who are similar in skill levels, experience, and biological maturity rather than in chronological age. When chronological age groupings are used, such groupings should never exceed more than a two year span for athletes under 16 years of age. The practice of assigning teams through lotteries, by player auction, and through recruiting should be replaced by the practice of equating all the teams prior to the assignment, en masse, of teams to particular coaches. Necessary competencies and levels of proficiency could be identified to aid teachers and coaches in determining the necessary prerequisites for success in a given sport. Finally, children should be given the opportunity to participate in a number of sports and to play many positions within a single sport so that they may learn a variety of skills which will serve them throughout their lifetime. The quality of the sport experience can be enhanced by understanding teachers and coaches who deal with children as children, and who provide an understanding, accepting, and encouraging atmosphere.

Another area of concern is the effect of winning and losing on children. Children who are subjected to constant losing frequently attribute that losing to decreased ability. On the other hand, those children who consistently win often attribute winning to increased ability and effort. Thus, perceptions associated with winning often result in increased motivation and task persistence, while perceptions associated with losing frequently result in "dropping out" or quitting. It is imperative that teachers, coaches, and parents remove children from activities if participation ensures consistent losing. Often the best interests of children can be served by rotating them among teams to diminish the problems of consistent winning and losing.

Finally, teachers and coaches need to analyze carefully the awards and rewards given to children in competitive situations. Rewards given for participation only, rather than for quality of performance, can result in diminished intrinsic motivation. Thus, the common practice of giving ribbons, certificates, and trophies to every participant may be detrimental. On the other hand, when awards are put into proper perspective, and when they are based on the quality of performance, they can provide the basis for intrinsic motivation of the participants. But the prospect of awards and winning should not be the focal point of, nor the reason for, participation.

Conclusion

This monograph offers many insights into the area of motor development and seeks to identify some key concepts and to provide examples of their application in teaching and coaching situations. We have noted that: activities and equipment must be modified to enhance the child's experience; competitive

situations must be put in proper perspective; the developmental level of the child is critical in determining activities; variety of activity leads to increased capacity; and children's sport should be designed for children. Improved experiences for children, provided through the efforts of concerned teachers and coaches, is likely to increase the chances of the child's learning, playing and participating throughout his or her lifetime.

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